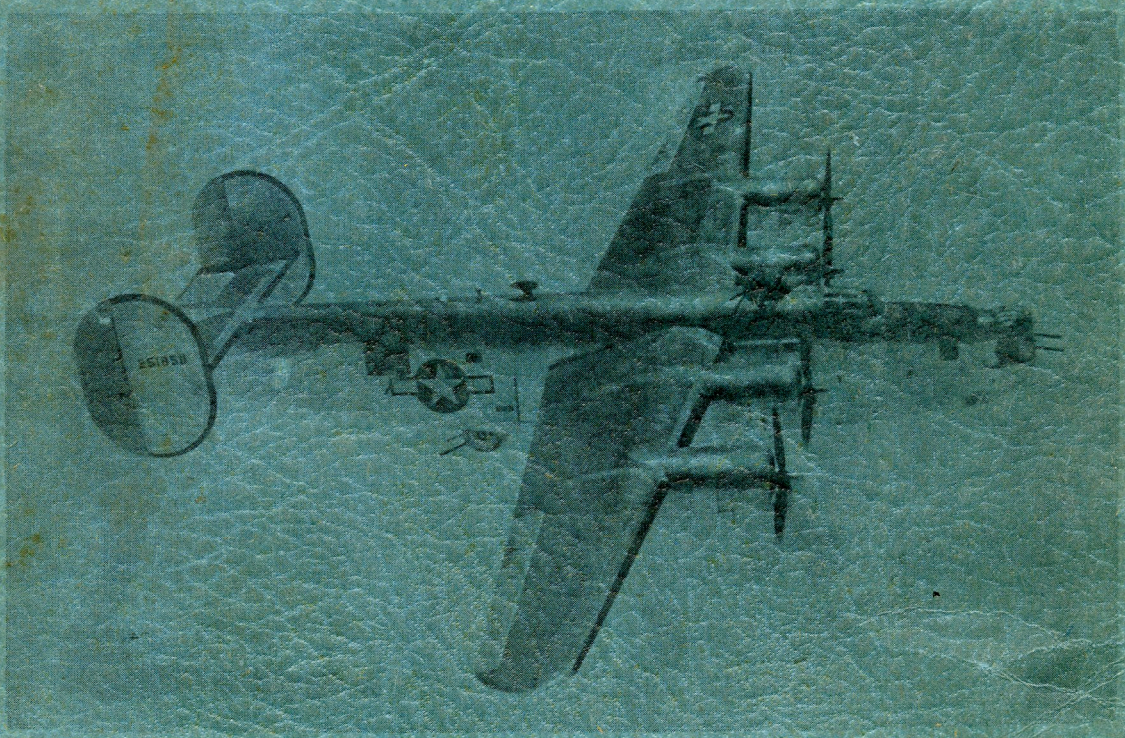
LIBERATOR JOB SHEET MANUAL



3509th AAF BASE UNIT (F.S)

AIRPLANE & ENGINE MECHANIC COURSE
(SPECIAL B-24)

FORD AIRPLANE SCHOOL

WILLOW RUN *YPSILANTI, MICHIGAN*

IDENTIFYING SERIES OF TECHNICAL ORDER NUMBERS

T. O. SERIES	EQUIPMENT
00	INDEXED AND MAINTENANCE PUBLICATIONS OF A GENERAL NATURE
01	AIRPLANES AND MAINTENANCE PARTS - GENERAL
02	ENGINES AND MAINTENANCE PARTS - GENERAL
03	AIRCRAFT ACCESSORIES
04	AIRCRAFT HARDWARE AND RUBBER MATERIALS
05	AIRCRAFT INSTRUMENTS AND LABORATORY TEST EQUIPMENT
06	FUELS AND LUBRICANTS
07	DOPES, PAINTS AND RELATED MATERIALS
08	ELECTRICAL EQUIPMENT AND SUPPLIES
09	GLIDERS, TARGET PLANES AND SPARE PARTS
10	PHOTOGRAPHIC EQUIPMENT AND SUPPLIES
11	AIRCRAFT COMBAT MATERIAL
12	FUEL AND LUBRICATING EQUIPMENT AND SUPPLIES
13	CLOTHING, PARACHUTES, EQUIPMENT AND SUPPLIES
14	HANGARS AND DEMOUNTABLE BUILDINGS
16	GAS CYLINDERS
17	MACHINERY, SHOP EQUIPMENT AND TOOLS
18	SPECIAL TOOLS
19	FLYING FIELD AND HANGAR EQUIPMENT
22	WOODS
23	METAL AND COMPOSITION MATERIAL
24	CHEMICALS
25	OFFICE EQUIPMENT AND SUPPLIES
29	COMMERCIAL HARDWARE AND MISCELLANEOUS SUPPLIES
30	PROCESS MANUALS

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

TECHNICAL ORDERS TO BE PLACED IN STUDY HALL - PHASE I

1. T.O. #00-15-1 --The Army Air Forces Technical Inspections Manual.
   Part 1 Sections 1-2-3-4-5-6.
   Part 2 Sections 6.

2. T.O.#00-20A --Visual Inspection System for Airplanes.
   Sections 1-2-3-4-5-6.

3. T.O.#00-20A --Visual Inspection Systems for Airplanes.

4. T.O.#00-20A-2 --Airplane Maintenance Instruction Forms.

5. T.O.#00-25-9 --Preparation of Freight for Air Shipment.
   Sections 1-2-3-4-5.

6. T.O.#00-40-1 --Silhouette Handbook of U.S. Army Air Forces Airplanes.

7. T.O.#01-1-1 --Cleaning Aeronautical Equipment.

8. T.O.#01-1-2 --Anti-Corrosion for Airplanes Operating in Salt Water.

9. T.O.#01-1-3 --Airplane Finishes.

10. T.O.#01-5-6 --Airplane and Maintenance Parts (Adj. of Elevator Trim Tab Servo Movement and Elevator Control Tension).

11. T.O.#01-1-26 --Frayed Control Cables.

12. T.O.#01-1-29 --Use of Surface Control Lock and Inspection of Surface Controls.

13. T.O.#01-1-7 --General - Long Time Storage of Airplanes.

14. T.O.#01-1-8 --Ventilation of Airplane in Hot Weather.

15. T.O.#01-1-9 --Rigging Tension of Control Cables.

16. T.O.#01-1-12 --General - Inspection of Airfoils.

17. T.O.#01-1-50 --Towing - Mooring and Handling of Airplane.

18. T.O.#01-1-57 --Lubrication of Control Cables.

19. T.O.#01-1-67 --Arctic Operation.
    Sections 1-2-3-4-5.

20. T.O.#01-1-109 --Precautions Against Fouling Controls.

21. T.O.#01-5EC-2 --Handbook of Service Instruction.
    Section I-2-3-4.

22. T.O.#01-5E-3 --Section I - General Repair -- Section II-Wing.

23. T.O.#01-5E-21 --Installation of Mechanical Bomb Door Up Lock.

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

TECHNICAL ORDER QUESTIONS

1. What do red X's on the border of a T.O. mean? _____

2. What do red /'s on the border of a T.O. mean? _____

3. How can one tell from the T.O. index whether a specified T.O. will be at his field or not? _____

4. How can one tell where at his field he will find a particular T.O.? _____

5. What is the subject code number of Consolidated aircraft? _____

6. How can one locate the T.O. number of the engine used on a BT-12? _____

7. What is the "G" File? _____

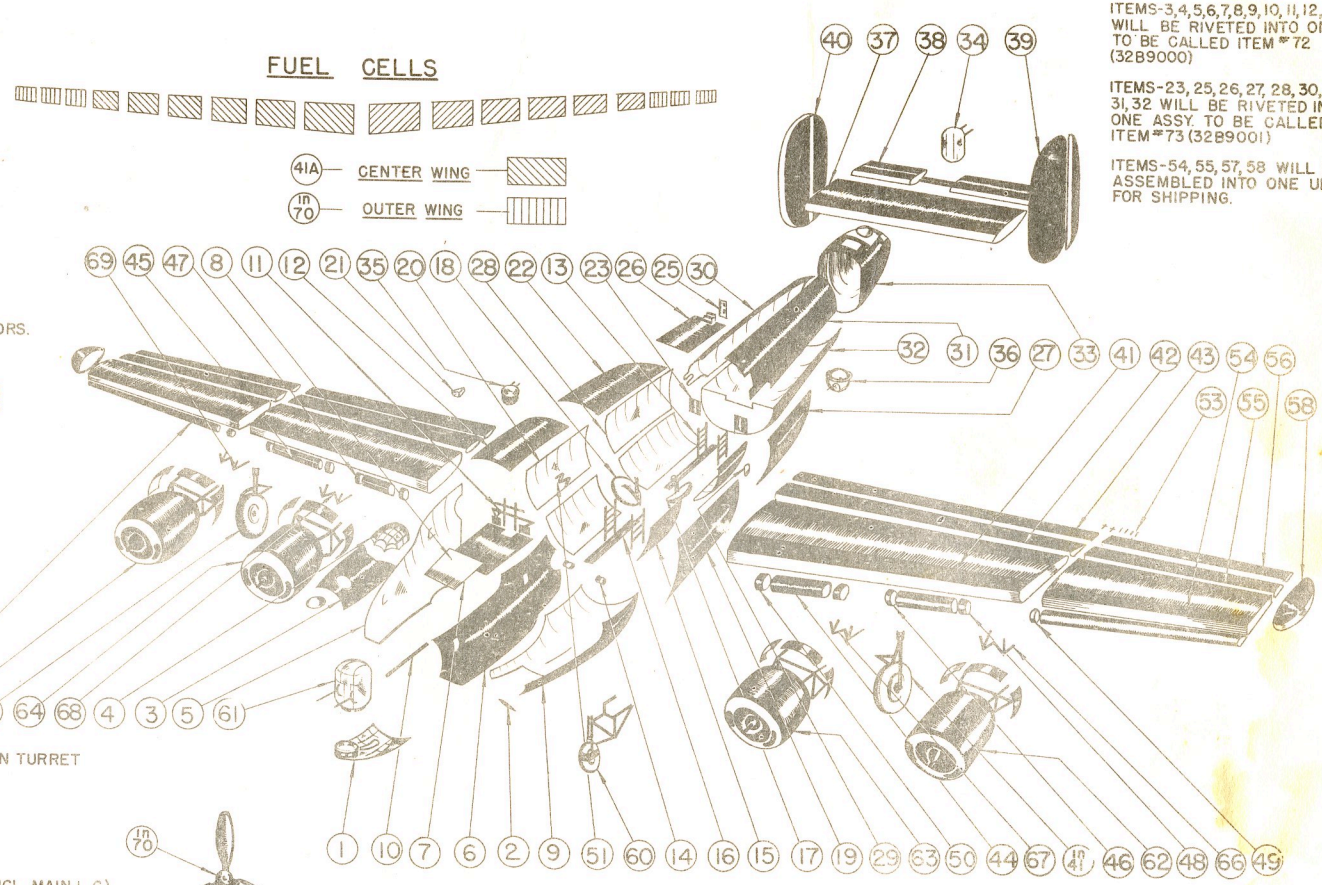
8. What information is given in Form 263A in regard to the equipment on a plane? _____

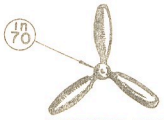
9. What other pertinent information is given in parts 2, 3, 4, and 5 of Form 263A? _____

10. Identify: Form 60A _____
Form 60B _____
Form 61 _____

FORD B24 BREAKDOWN

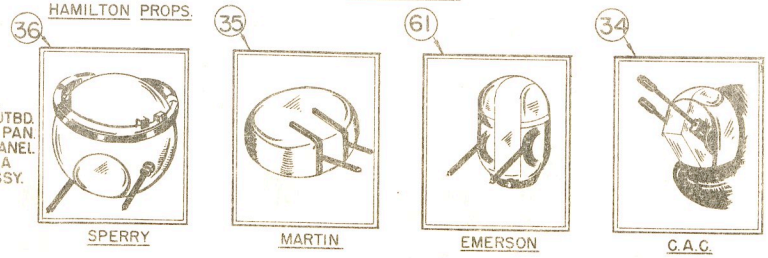
DEPT.	ITEM		
932	1	32B1709-P	BOMBARDIER'S ENCLOSURE
916	2	32F3135-3L/R	PITOT TUBES
938	3	32B1705-2	FUS. NOSE SECT. UPPER FRT. 0.1 TO 2.0
932	4	32B9144	PILOT'S ENCLOSURE
938	5	32B1737-2	FUS. NOSE SIDE PANEL R.H. 0.1 TO 4.15
938	6	32B1736-2	FUS. NOSE SIDE PANEL L.H. 0.1 TO 4.15
914	7	32B9146	PILOT'S FLOOR
914	8	32B9146	RADIO OPERATOR'S FLOOR
938	9	32B1716-2	FUS. NOSE BOTTOM PANEL
938	10	32F3294-2	HAND RAIL. ITEM 10 IS A GROUP OF SMALL PARTS INSTALLED INTO ITEM 5.
942	11	32B1741-0	TRUSS BLKHD. STA. 4.1
938	12	32B1727-2	FUS. NOSE SEC. UPPER REAR DECK. 2.0-4.0
930	13	32F4799-2-3-4-5	BOMB RACK
916	14	32B9145 L/R	-32 L/R SEGMENTS BLKHD. STA. 4.0 SEGM'TS.
930	15	32B046	(-139 L/R)(-140 L/R) BOMB BAY DRS.
942	16	32B9014-0	LOWER LONGERON 4.0 TO 6.0
942	17	32B1750-0L	BLKHD. 5.0 L.H. PORTION.
942	18	32B1750-0R	BLKHD. 5.0 R.H. PORTION.
938	19	32B1795-2	SIDE PANEL L.H. 4.15 TO 5.25
938	20	32B1796-2	SIDE PANEL R.H. 4.15 TO 5.25
941	21	32F9038	TRUSS REAR BOMB RACK.
938	22	32B1708-2	FUS. TOP DECK ABV. WING. 4.2 TO 5.1
942	23	32B9148 L/R	SEGMENT BLKHD. 6.0
	24		NOT REQUIRED
930	25	32B1218-6	DOOR BLKHD. 6.0
942	26	32B1755-2	FLOOR 5.1 TO 6.0
938	27	32B1784-2L/R	FUS. SIDE PANEL BELOW WING 5.25 TO 6.0 L.H.
938	28	32B1785-2	FUS. SIDE PANEL BELOW WING 5.25 TO 6.0 R.H.
933	29	32F9712	HYDRAULIC RESERVOIR TANK
939	30	32B1788	FUS. UPPER R.H. SECT. 5.0 TO 7.7
939	31	32B1787	FUS. UPPER L.H. SECT. 5.0 TO 7.7
939	32	32B1786	FUS. BOTTOM SECT. 6.0 TO 7.7
939	33	32B1794-0	FUS. TAIL SECT. AFT. STA. 7.7
947	34	32F5800-3	TAIL TURRET
947	35	32GF8227	G. L. MARTIN ELEC. PWR. DRIVEN TURRET SK 6276
947	36	32GF8673	SPERRY TURRET
945	37	32T9352	STABILIZER
945	38	32T10503-2L/R	ELEVATOR ASSEMBLY
945	39	32T8050-0	FINS
945	40	32T10115-3L/R	RUDDERS
936	41	32W9375	WING CENTER SECT. VERT.
937	41	32W1701-P	WING CENTER SECT. HORIZ. (INCL. MAIN L.G.)
937	41A	32G1039-4	FUEL CELLS L/R.
943	42	32W520-2L/R	WING CENTER SECT. TRAILING EDGE
943	42	32W9350 L/R	SHORT SECTION
943	43	32W500-2L/R	FLAP.
943	44	32W9337L/R	CENTER WING SECT. LEADING EDGE.
943	45	32W9338L/R	WING CENTER SECT. LEADING EDGE. BETWEEN NAC.
943	46	32W2067-2L/R	INBD. NACELLE TO WING L.E. FAIRING INBD.
943	47	32W2068-2L/R	INBD. NACELLE TO WING L.E. FAIRING OUTBD.
943	48	32W2069 L/R	NACELLE L.E. ATTACHING STUB INBD. SIDE OUTBD.
935	49	32W2070 L/R	NACELLE L.E. CONNECTION STUB & ACCESS PAN.
943	50	32W302-0L-0R	WING CENTER SEC. LEADING EDGE ATTACH. PANEL.
932	51	32B045-2	TRUSS FUS. TO WING 4.1 TO 4.2 ITEM 51 IS A GROUP OF LOOSE PARTS INST. AT FINAL ASSY.
	52		NOT REQUIRED
947	53	32W521-3L/R	FLAP TRACK SUPPORTS GROUP OF LOOSE PARTS INST. AT FINAL.
935	54	32W12003-135L/R	WING OUTER PANEL.
935	55	32W026 L/R	WING OUTER PANEL TRAILING EDGE.
945	56	32W10573-2L/R	AILERON
935	57	32W9392 L/R	WING OUTER PANEL LEADING EDGE
935	58	32W1024-0L/R	WING TIP
	59		COMBINED WITH ITEM 32
947	60	32L003	NOSE LANDING GEAR





HAMILTON PROPS.

TURRETS



SPERRY MARTIN EMERSON C.A.C.

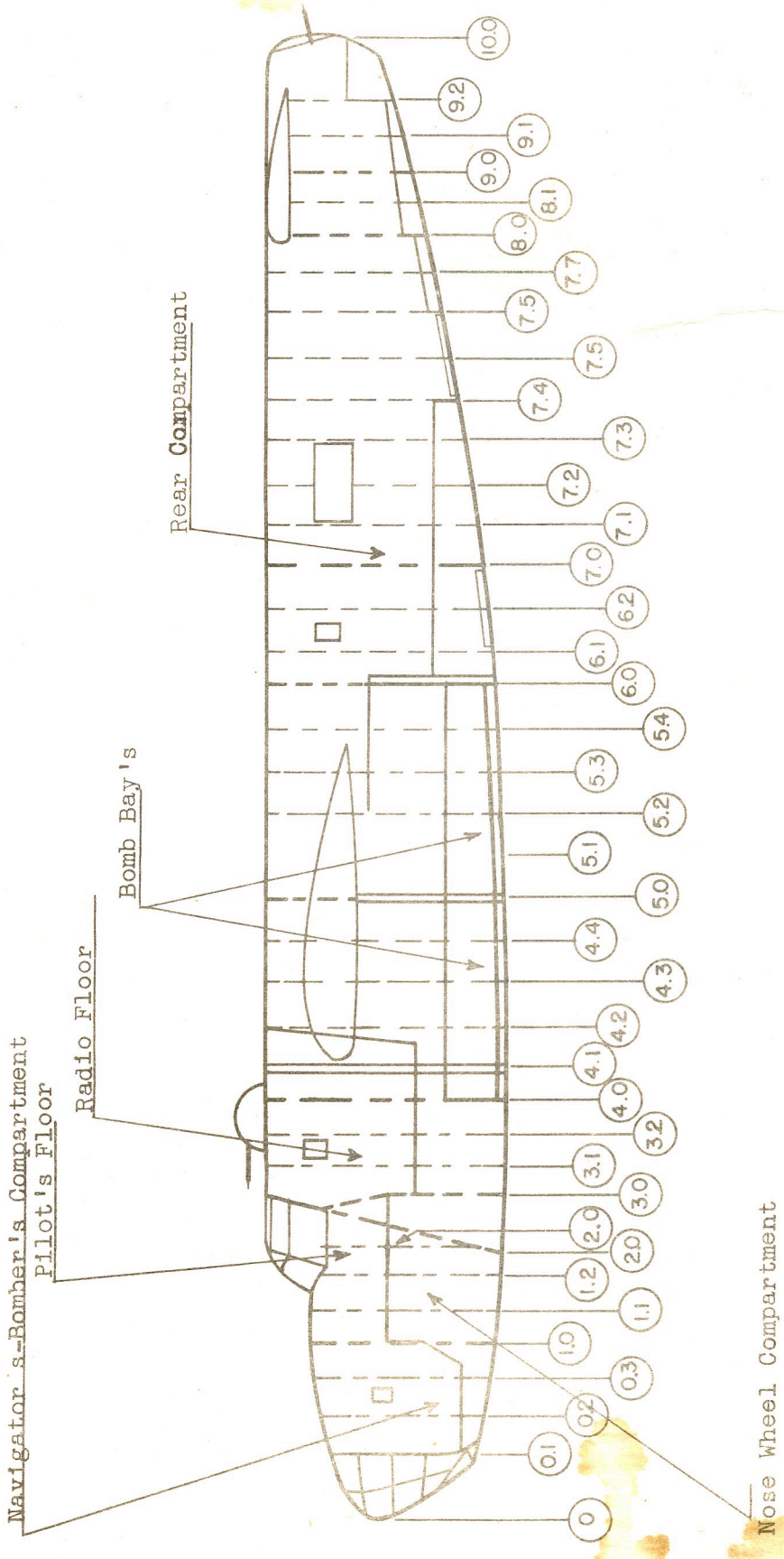
947	61	32GF8687	EMERSON TURRET
944	62	32P9101	NAC. POWER PLANT INST. L.H. OUTBD.
944	63	32P9102	" " " " " INBD.
944	64	32P9103	" " " " R.H. OUTBD.
944	65	32P9104	NAC. PWR. PLANT INST. R.H. INBD.
944	66	32P9111	TURBO INST. L.H. OUTBD.
944	67	32P9112	" " " INBD.
944	68	32P9113	TURBO INST. R.H. INBD.
944	69	32P9114	TURBO INST. R.H. OUTBD.
947	70		PTS. LIST MISC. LOOSE
	71		NOT REQUIRED PTS.
940	72	32B9000	NOSE ASSY.
940	73	32B9001	FUS. ASSY. STA. 5.1 TO 7.7 (NOTE)

NOTE

ITEMS-3,4,5,6,7,8,9,10,11,12,14 WILL BE RIVETED INTO ONE TO BE CALLED ITEM #72 (32B9000)

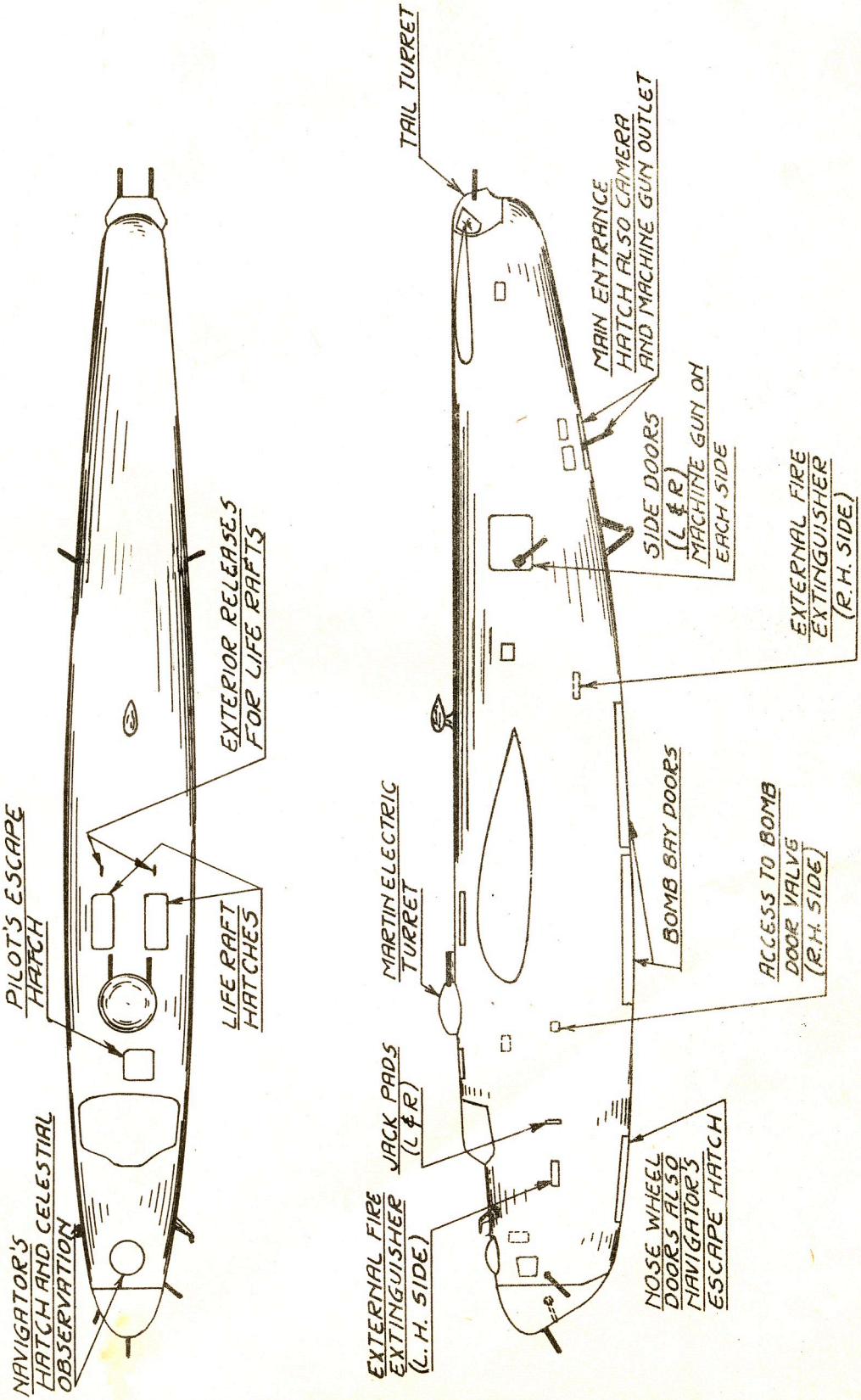
ITEMS-23,25,26,27,28,30, 31,32 WILL BE RIVETED INTO ONE ASSY. TO BE CALLED ITEM #73 (32B9001)

ITEMS-54,55,57,58 WILL BE ASSEMBLED INTO ONE UNIT FOR SHIPPING.

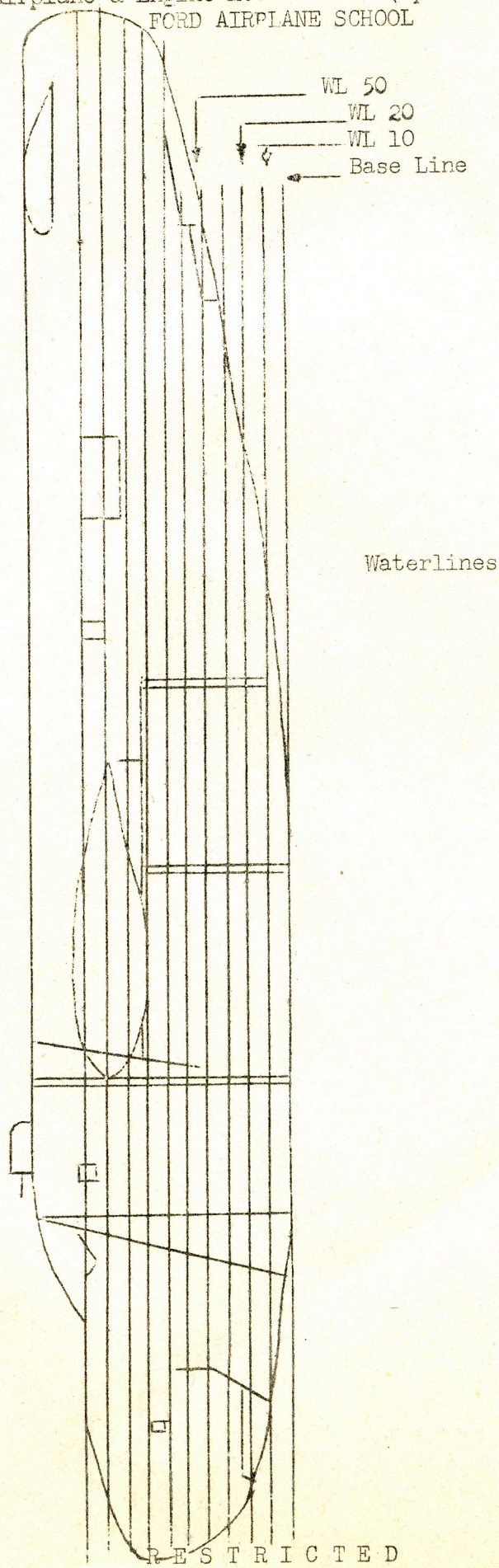


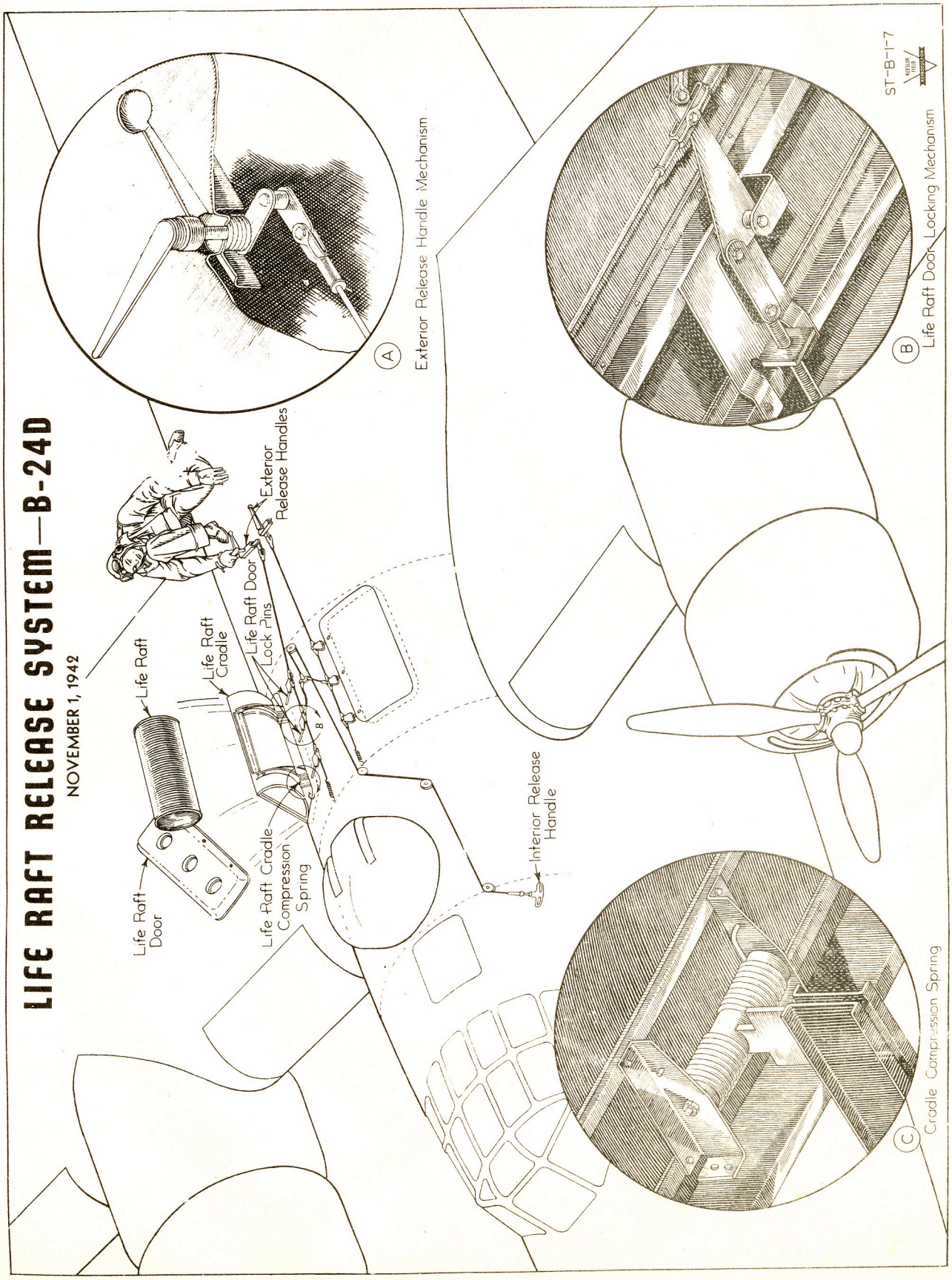
FUSELAGE STATIONS DIAGRAM

FUSELAGE ACCESS DOORS



Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL




LIFE RAFT RELEASE SYSTEM—B-24D
NOVEMBER 1, 1942
Life Raft
Life Raft Door
Life Raft Cradle
Life Raft Door Lock Pins
Exterior Release Handles
Life Raft Cradle Compression Spring
Interior Release Handle
A
Exterior Release Handle Mechanism
B
Life Raft Door Locking Mechanism
C
Cradle Compression Spring
ST-B-1-7

Airplane & Engine Mech Course (Special B-24)
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FUSELAGE QUESTIONS

1. The fuselage of the B-24 is of _____ type construction.

2. Five structural parts of the B-24 fuselage are: _____

_____

3. Generally speaking, the whole number or major stations are identified by _____ while the decimal or minor stations are identified by _____.

4. Locate compartments by stations. _____

_____

_____

5. What are waterlines? _____

_____

6. How are wing stations determined? _____

7. How many hoisting points on the following parts of the ship are there?

Center wing_____ Outer wing panel_____ Empennage_____

8. How many jacking points on the following parts of the ship are there?

Fuselage_____ Wings_____ Main landing gear struts_____

9. How many mooring points on the following parts of the ship are there?

Wings_____ Main struts_____ Nose strut_____

10. From what positions on the ship may one open the bomb bay doors?

_____

_____

11. What precautions must be observed in opening the bomb bay doors manually?

_____

12. What is the procedure for the removal of the bomb bay doors? _____

_____

_____

Airplane & Engine Mech Course (Special B-24)
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FUSELAGE QUESTIONS (Cont'd)

13. Where are the handles located for the release of the life rafts?

_____

14. How are the outer wing panels attached to the center wing section?

_____

15. How are the wing tips attached to the outer wing panels? _____

_____

16. How are the wing leading edges attached? _____

17. How are the wing trailing edges attached? _____

_____

18. How many bolts hold the empennage to the fuselage? _____

19. How many bolts hold a vertical stabilizer to the horizontal stabilizer?

_____.

20. What is magnafluxing? _____

_____

21. Can the rudders be interchanged? _____ Elevators? _____

Vertical stabilizers? _____ Flaps? _____ Ailerons? _____

Tabs? _____.

22. Where are the primary stops for the rudder? _____

_____ Elevator? _____

23. Where is the locking unit for the rudders and the elevators? _____

_____

24. Why was paint removed on ship? _____

25. What is aerodynamic cleanliness? _____

26. Why is aerodynamic cleanliness of more importance on faster ships than

on slower ships? _____

27. What is the ratio between increase in speed and power? _____

_____

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

REMOVAL AND INSTALLATION OF FUEL CELLS

Introduction

Fuel may be stored in the main fuel tanks, the auxiliary wing tanks, and the bomb bay tanks.

Most of the fuel in the B-24 is contained in the twelve main fuel cells. These cells, resistant to aromatic fuel, are located in the wing center section, six on each side of the airplane center line. The main cells have a maximum capacity of 2364 U.S. gallons. The cells are designated as Nos. 1,2,3,4,5 and 6 (left and right) with No. 1 cell the farthest inboard. The cells are connected to form four systems, two each side of the airplane, as follows: Cells Nos. 1,3 and 5 (left) form the system for the No.2 engine; cells Nos. 2, 4 and 6 (left) form the system for No. 1 engine; cells Nos. 1,3 and 5 (right) form the system for the No. 3 engine; and cells Nos. 2, 4 and 6 (right) form the system for the No. 4 engine.

There are six auxiliary wing cells. They are designated as cells 7, 8 and 9 (left and right) and are located just outboard of the wheel wells. Their maximum capacity is 450 gallons. For use, the fuel from these cells must first be pumped into the cross-feed line through the bomb bay pump located on the catwalk at Sta.5.0

The two bomb bay tanks, if installed, are located in the forward bomb bay. Their maximum capacity is 780 gallons.

To Remove Main System Fuel Cells

If all the fuel cells are to be removed, cell No. 3 and No. 4 should be removed first. If cells No.1 and No.2 are to be removed, No.3 should be removed first. If cells 4, 5 and 6 are to be removed, No. 4 should be removed first.

Preliminary Procedure

Drain cells by closing the selector valve for the system to be drained and disconnect the cross feed line. Then attach a suitable drain tube and place the selector valve handle in the position marked "No. X Tank to No. X Engine and Cross Feed."

Caution: Before draining the system, the airplane must be grounded from the receptacle tank and to the ground. Use every precaution against fire.

Remove the large and small access doors on the lower surface of the wing, between inboard nacelle and the airplane center line. Access to the cell No.6 manifold connection is through the access door on the inboard side of the inboard nacelle. To remove large access door, remove attaching screws around door both outside and inside fuselage. Also remove screws from plate below door on fuselage skin. Drop access door and remove outboard.

Through the small access openings remove the metal connector tubes from the manifold hose. When removing these tubes, be careful not to damage the manifold hose and cell fittings. Work the castings out of the hose by applying pressure to ends of the hose with a blunt tool. If metal connector tube has a tendency to stick, loosen by squirting benzene around it.

Remove the stainless steel center support plates (bed plates) from beneath cells Nos. 3 to 5 inclusive by raising the aft end of the plates until the dowel pins are clear of the holes. Remove the plates through the large access doors.

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

To Remove Cell No. 3 and No. 4.

Detach and remove the filler cap and safety chain from inside the filler neck on the top surface of the wing. Then remove the countersunk screws from the upper surface of wing around the filler neck. The Technical Order will tell you that this will release the cell enough so that next it is possible to reach down through the hole and disconnect the bellows hose. While this work is being done another group may be removing the safety stitching from the bottom of the inboard and outboard stiffener tunnels and then by using long nose pliers, remove the stiffeners. Number the stiffeners and tape those from each side in a separate bundle. Disconnect the manifolds.

These cells can be removed without the use of straps. This can be accomplished by having a man put his shoulders to the cell and collapse the cell up against the top of the wing. Then reach into the wing and pull the forward end of the cell back until that end comes out through the main access door in the lower surface of the wing. Now if the bellows hose has not been removed, pull the forward end of the cell back until there is a hole large enough for a man to crawl into the wing and disconnect it. Pull the cell clear of the opening with the man in the wing assisting.

To Remove Cell No. 2.

After the preliminary work is done remove the bulkhead curtain. Disconnect the manifold connections on the bottom of the tank. Reach over from cell room No. 3 and disconnect vent fitting.

Remove the stiffener rods the same as cell No. 3 and tape them into bundles. Remove the bomb release control rods and disconnect the sight gage fittings attached to the lower surface of the wing in the bomb bay. Plug the tubes to keep out the dirt.

Remove the booster pump attaching studs which are on the lower surface of the wing in the bomb bay. Remove the pump, taking care not to damage the grommet.

In the model "E", disconnect the transfer tube and hose fittings from the top of the wing inside the fuselage and remove the nut fitting which holds the top of fuel cell No. 2 in position.

Pass two web straps as far from each side of center as possible around the cell. Collapse the cell and secure it in the collapsed condition by tightening the straps.

Push center of collapsed cell up as far as possible. Pull forward end of the cell back until it is over the access opening. Now turn the forward end of the cell to the top of the cell faces toward the center of the airplane in order to clear the fuselage and the control cables. Pull down the cell and remove it through the bomb bay opening.

To Remove Cell No. 1.

Remove the inboard and outboard curtains from wing bulkhead No. 1. After this has been completed, detach and remove the center truss by removing bolts from the top and bottom of structure from wing bulkhead 1.

Remove the safety stitching at the bottom of the outboard stiffener from the tunnels. Pull the top of the outboard cell so the inboard side is accessible. Remove the safety stitching at the top of the inboard stiffeners and remove the stiffeners.

Remove the fittings on the bottom and the top of the wing the same as cell No. 2. Disconnect the vent connections at the top of the cell by reaching through station No. 2 opening. Pass two web straps around the cell, collapse the cell, and secure it with the straps.

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Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

To Remove Cell No. 3 and No. 4.

Detach and remove the filler cap and safety chain from inside the filler neck on the top surface of the wing. Then remove the countersunk screws from the upper surface of wing around the filler neck. The Technical Order will tell you that this will release the cell enough so that next it is possible to reach down through the hole and disconnect the bellows hose. While this work is being done another group may be removing the safety stitching from the bottom of the inboard and outboard stiffener tunnels and then by using long nose pliers, remove the stiffeners. Number the stiffeners and tape those from each side in a separate bundle. Disconnect the manifolds.

These cells can be removed without the use of straps. This can be accomplished by having a man put his shoulders to the cell and collapse the cell up against the top of the wing. Then reach into the wing and pull the forward end of the cell back until that end comes out through the main access door in the lower surface of the wing. Now if the bellows hose has not been removed, pull the forward end of the cell back until there is a hole large enough for a man to crawl into the wing and disconnect it. Pull the cell clear of the opening with the man in the wing assisting.

To Remove Cell No. 2.

After the preliminary work is done remove the bulkhead curtain. Disconnect the manifold connections on the bottom of the tank. Reach over from cell room No. 3 and disconnect vent fitting.

Remove the stiffener rods the same as cell No. 3 and tape them into bundles. Remove the bomb release control rods and disconnect the sight gage fittings attached to the lower surface of the wing in the bomb bay. Plug the tubes to keep out the dirt.

Remove the booster pump attaching studs which are on the lower surface of the wing in the bomb bay. Remove the pump, taking care not to damage the grommet.

In the model "E", disconnect the transfer tube and hose fittings from the top of the wing inside the fuselage and remove the nut fitting which holds the top of fuel cell No. 2 in position.

Pass two web straps as far from each side of center as possible around the cell. Collapse the cell and secure it in the collapsed condition by tightening the straps.

Push center of collapsed cell up as far as possible. Pull forward end of the cell back until it is over the access opening. Now turn the forward end of the cell to the top of the cell faces toward the center of the airplane in order to clear the fuselage and the control cables. Pull down the cell and remove it through the bomb bay opening.

To Remove Cell No. 1.

Remove the inboard and outboard curtains from wing bulkhead No. 1. After this has been completed, detach and remove the center truss by removing bolts from the top and bottom of structure from wing bulkhead 1.

Remove the safety stitching at the bottom of the outboard stiffener from the tunnels. Pull the top of the outboard cell so the inboard side is accessible. Remove the safety stitching at the top of the inboard stiffeners and remove the stiffeners.

Remove the fittings on the bottom and the top of the wing the same as cell No. 2. Disconnect the vent connections at the top of the cell by reaching through station No. 2 opening. Pass two web straps around the cell, collapse the cell, and secure it with the straps.

Remove cell No. 1 from the wing by turning the cell on its side and passing the forward end through the bulkhead and out through the access opening.

To Remove Cell No. 6.

Remove curtains from both sides bulkhead 5. Now the center truss must be removed from bulkhead 5 by removing upper and lower bolts. The vent and manifold fittings are disconnected next.

Since cell No. 6 must pass through cell No. 5 opening, much difficulty has been encountered if No. 6 cell is folded the conventional way. Another method has been devised to simplify both removal and installation of cell No. 6.

Remove the top stiffeners leaving the side stiffeners intact. Deflate by applying pressure at upper inboard edge pressing it in until that edge rests parallel and alongside of the lower outboard edge. (Push it diagonally.) Then fold the ends in and down so that they lie as flat as possible on the cell. Then fold the outboard half over the inboard half and pass three straps around the cell and remove.

To Install Main System Fuel cells

General Notes on Fuel Cell Installation

Inspect inside the cell for flaws and then install inspection doors. Tighten the screws with the required amount of torque stated on the inspection plate. This may vary from 35 to 75 in. lbs. Safety the nuts together using No. 32 safety wire.

Wherever possible, warm cell to room temperature (approximately 65 degrees to 100 degrees F.) before collapsing. Do not allow cell to remain in collapsed condition for more than 30 minutes. Dust all exterior surfaces of collapsed cell with talc or soapstone.

Be careful that the cell isn't bent at the inspection door or at any point where fittings join the cell.

Do not lift fuel cells by their fittings and do not allow cells to rest on fittings. Rest them on their sides.

Be sure that all openings in the cell are covered while cell is out of the airplane. Where clamps hold hose and fittings, the hose and fitting should be wrapped with tape and shellaced.

Cell stiffeners may be most easily replaced by coating with soapy water. Do not drive into place. The channel should face the cell. Do not use oil or grease on stiffeners.

The beveled end of each stiffener should be inserted first to make entrance easier and to prevent injury to the cell.

If the cell doesn't inflate easily after it is in the wing, inflate with compressed air through the manifold connection.

Install booster pumps carefully so that gaskets are not damaged. Do not pry on fittings or cells with sharp instruments of any kind.

No. 8 and No. 10 clamps are used on the bellows hose connections. No safety wire is used, but the clamp is taped so that no metal shows. Have the clamp parallel to the wing and the cell. Shellac is placed over the tape.

To Install Main Wing Cells.

These cells are installed by reversing the removal procedure with the following exceptions:

Four web straps should be used to hold cell in collapsed position, except for No. 6 cell, where only three straps are necessary.

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It is best to install cells Nos. 1 and 6 first. However, No. 2 may be strapped down, placed in its compartment, and left resting on edge against the outboard bulkhead until No. 1 is installed. This provides a larger opening through which to put No. 2 cell. No. 1 must be installed as quickly as possible after No. 2 is placed in the wing so that No. 2 may be unstrapped.

After cells Nos. 1 and 6 have been installed, make certain that the removable bulkhead trusses are replaced and securely fastened.

With the exception of the last cell installed, always place one man in the leading edge and one man in an adjoining cell compartment to assist in putting in the cells. This man in the leading edge can also make the vent connection. He can crawl out of a lightening hole except in the last cell installed when he can slip out between the cell and the access door opening. He should take out the two forward straps

To Install Cell No. 1

Fold the cell in the regular manner, and strap it. This cell must go through No. 1 hole, and so special precautions must be taken. While the cell is lying on the floor, bend the cell about 1½ ft. from the rear end, so it is very pliable and will bend easily.

Push the cell up in No. 1 hole, having one man in the rear of the No. 2 and one in the front of No. 1 cell compartment. As the cell goes through No. 1 hole, fold the aft end forward and strap down. Twist the cell to the right and aft. Have one man inside push with his feet and the other man bend the cell against the bottom of Wing St. #1, Push the cell to the extreme end of the station, bend the end of the cell down and push the center upward against the top of the wing. Now push it into place.

Make the necessary connections, namely, booster pump, sight gage fittings, manifold connections, and vent fittings.

Installation of Cells 2, 3, 4 and 5.

Fold cell in the regular manner and tie down with four straps. Place men inside the wing as per preliminary instructions and with as many men as possible lying on their backs and pushing with their feet, push the cell up into the wing.

The man in the leading edge should make the air vent connection and then crawl out through a lightening hole or between the cell and the main access door opening.

Assist the cell the rest of the way into the wing and make proper connections.

On cells Nos. 3 and 4, the filler cap connections must be made. Put two studs across filler cap on fuel cell. Install the cell and insert the filler neck tool and pull up on the bag until studs come up through the wing. Put nuts on the studs and screw up tight if it is hard to line up the neck. Put all the Phillips screws in and place a bolt in the hole that is not countersunk and safety.

The shorter bellows hoses are used on the No. 3 and 4 tanks and longer hoses on all the rest.

To Install Cell No. 6.

Fold the cell in the same manner as it was taken out and tie it down with three straps. (Use accompanying diagram). Always make certain that the cell is started to deflate from the inboard to the outboard side.

Replace stiffeners the reverse of which they were taken out.

Replace Access Doors

Replace the large access doors on the lower surface of the wing. Four different type screws are used. In the blue colored area use 10-9. In the black area use 10-10. In the red area use 10-11, and in all others use 10-8.

In the small access plates use the following screws: Under the lock plates use 10-6. In the lock plates use 10-9. In the rest use 10-12. There are two exceptions in the trailing edge of the two outboard plates where 10-14 are used.

Manifold Connections (Fuel Cells)

1. Seat cell flat on floor of bay.
2. Put a #11 Phillips screw in 3rd screw hole from hose end of inspection door, one screw on each side of door.
3. Using a smooth wooden or fiber flock (2 X ½ X 12), bend the hose which connects the cells together down and back.
4. Slide a short stiffener (12") over both screws in front of the bent interconnecting hose, securing the hose in a bent position pointing downward.
5. Tape end of hose with from 2 to 4 wraps for a thin walled hose.
6. Inspect clamps carefully for edge straightness and condition of screw, washer, and clampers.
7. Put 2 clamps (32G9518) on hose.
8. Flatten or elongate clamps and hose to accomodate casting or "liner."
9. Grease one half of liner and inside of hose with vaseline.
10. Insert liner into hose, keeping part number on liner on the bottom for use as guide to center liner in hoses. A 10" steel bar 1/8" thick and about 3/4" wide with rounded corners will be helpful in placing liner in hose.

N.B. Manifold connection or "pouch" on the cells which point outboard take liners with drains. Cell pouches which point inboard take plain liners.

11. Insert liner into hose so that the part number on the plain liner almost touches the hose. Insert liners with drains into hose so that the hose just touches the beginning of radius of the drain.
12. Place clamps close together, parallel with end of hose, and 1/4" from end of hose. See that they are exactly centered with respect to oval liner and are exactly opposite each other.
13. Tighten both clamps evenly to 12 inch pounds torque. Five or 6 threads usually show on these hose clamps. Never have less than 3 threads showing. Add more friction tape under clamps if necessary.
14. Grease the other half of the liner with vaseline. Use vaseline sparingly here.
15. Inspect clamps (32G9517) Carefully.
16. Elongate and install clamps on cell pouch.
17. Remove stringer and adjust hose so that correct clearance will be obtained between the hose and the cell pouch.

N.B. Hose may be pulled away from cell pouch by attaching a web strap to the other end and pulling. Pounding on other end will drive hose closer to pouch if need be. Hoses are usually too long and these new hoses must be cut off to fit the next cell. Cut new hoses off squarely.

18. Slip casting into cell pouch using steel tool.
19. Place clamps close together, parallel with end of hose, and 1/4" from end of hose. See that they are exactly centered with respect to oval liner and that the screws are exactly opposite each other.

20. Tighten evenly to 8 inch pounds torque.
21. Make sure upper arm of elbow of cell pouch hangs straight down. Do not allow any kinks to remain in pouch. Make sure that the ends of all four clamp screws are clear of the framework of the wing.
22. Place rubber protector on "Z" stringer at forward edge of manifold inspection door so that the cell pouch will not be cut on the stringer should the cell slip forward.
23. Replace inspection door.

TO DISCONNECT FUEL CELL VENT HOSE

T. O. Method:

1. Reach aft through filler cap opening on top of wing and remove tape from clamp holding hose to the fuel cell connection.
2. Loosen the clamp and slide bellows hose off leaving the hose attached to the vent in the top of the wing.
3. Remove cell.

Plant Method:

1. Force center of fuel cell to top of wing and pull forward end aft far enough to permit a man to stand between cell and front edge of wing opening. Be sure that the top of cell is kept near the top of wing to prevent damage to cell connection or hose until after hose is disconnected.
2. By reaching across top of cell, remove tape from clamp which holds the hose to the fuel cell connection. Loosen clamp and slide bellows hose from coupling leaving the hose attached to the vent in the top of the wing.
3. Remove cell.

TO CONNECT FUEL CELL VENT HOSE

T.O. Method:

1. To connect, reverse T.O. Procedure above and shellac tape.

Plant Method:

1. Bend cell upward to top of wing with forward end pulled aft sufficient for a man to enter between cell and front edge of wing opening. Keep top of cell near enough to top of wing to permit hose to be placed on coupling.
2. Place a No. 8 hose clamp on coupling, slide on hose and tighten clamp finger tight plus $\frac{1}{2}$ to $1\frac{1}{2}$ turns with pliers, or tighten so that it takes a strong hand to loosen it.
3. Tape clamp so that no metal shows.
4. Shellac the connection.
5. Put forward end of cell into wing but keep center of cell pushed up until filler connection is made. This prevents damage to connection.
6. Check connection through opening in top of wing.

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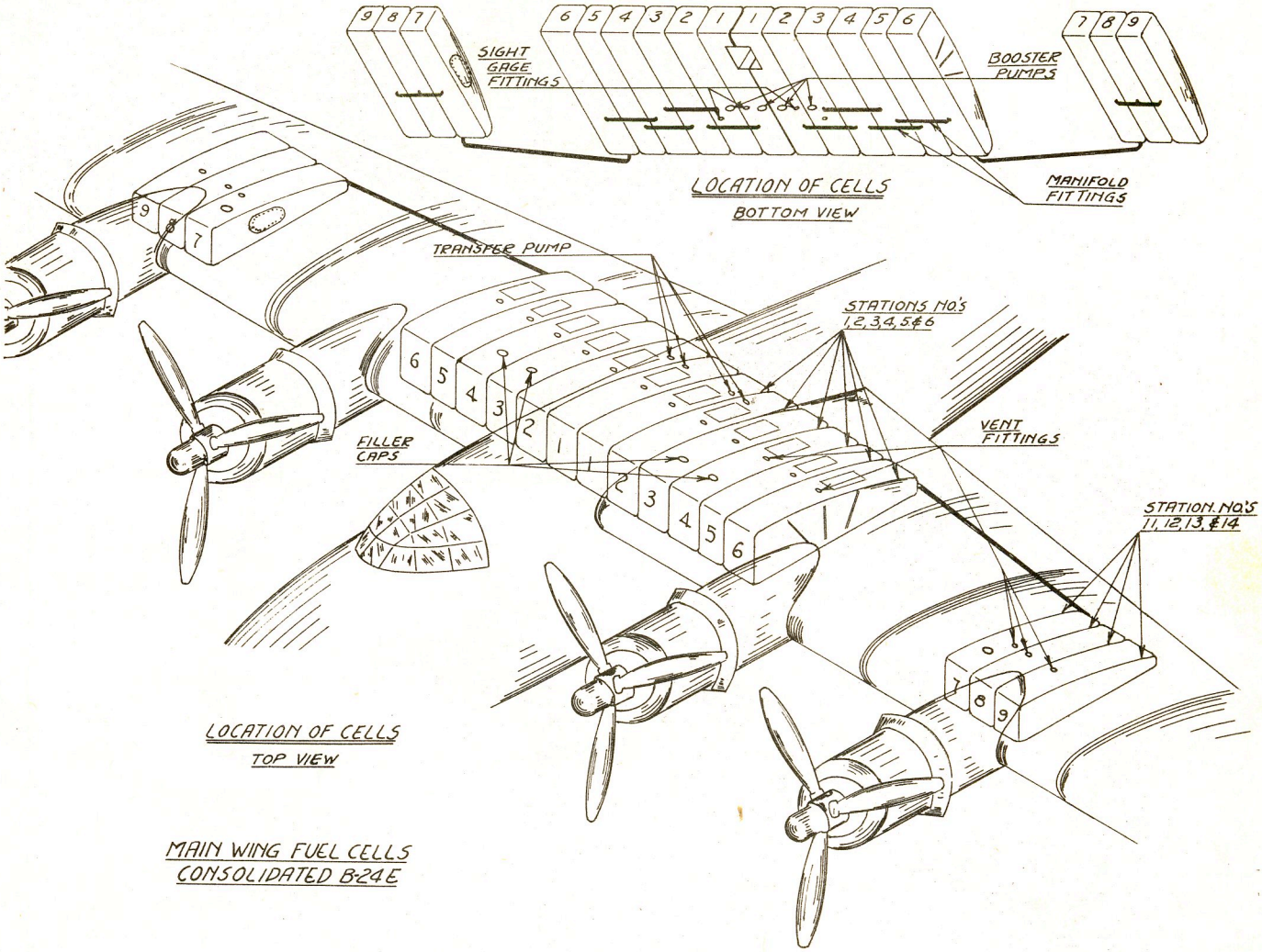
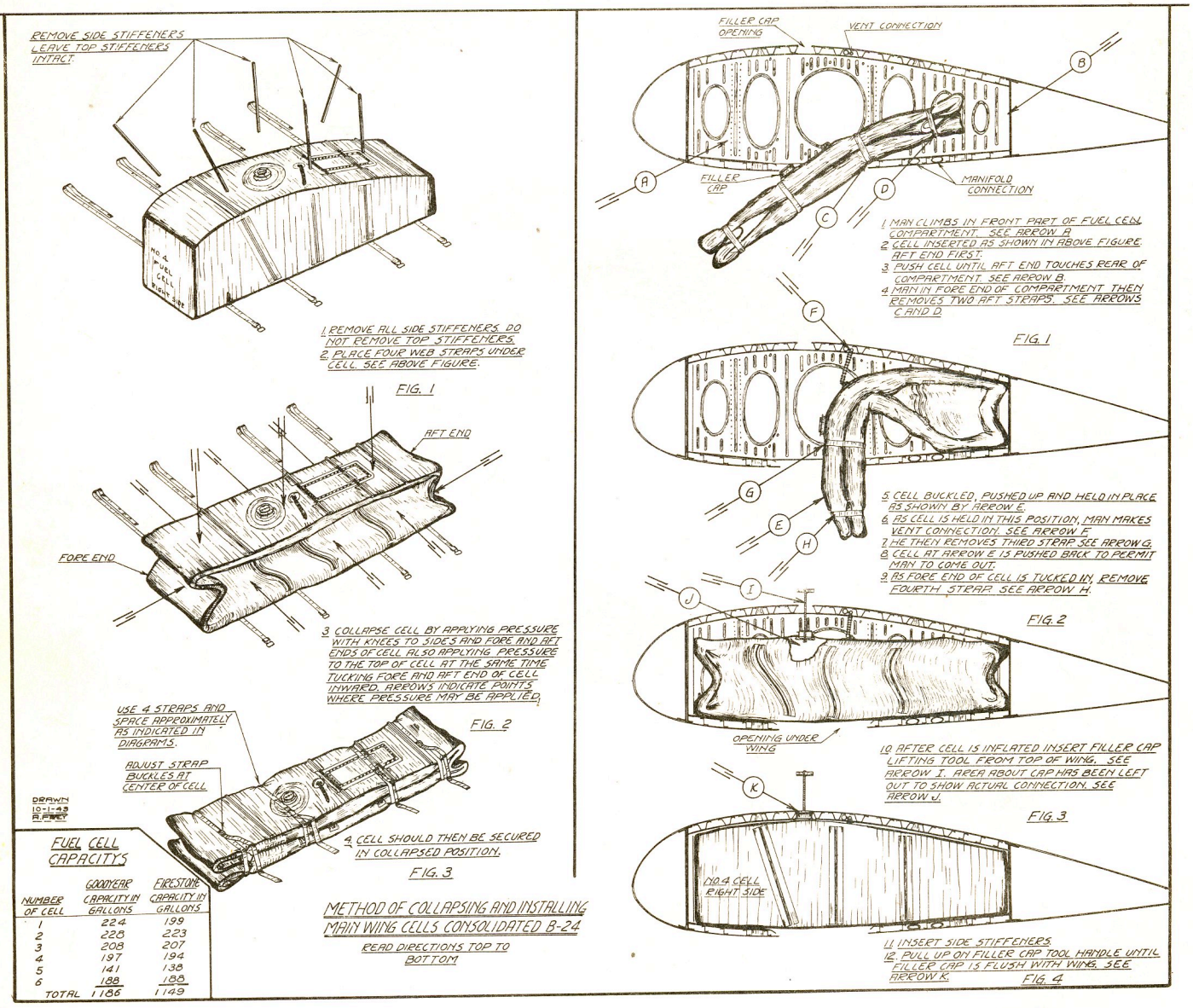
ARMY AIR FORCE



MAIN WING FUEL CELLS
CONSOLIDATED B-24E

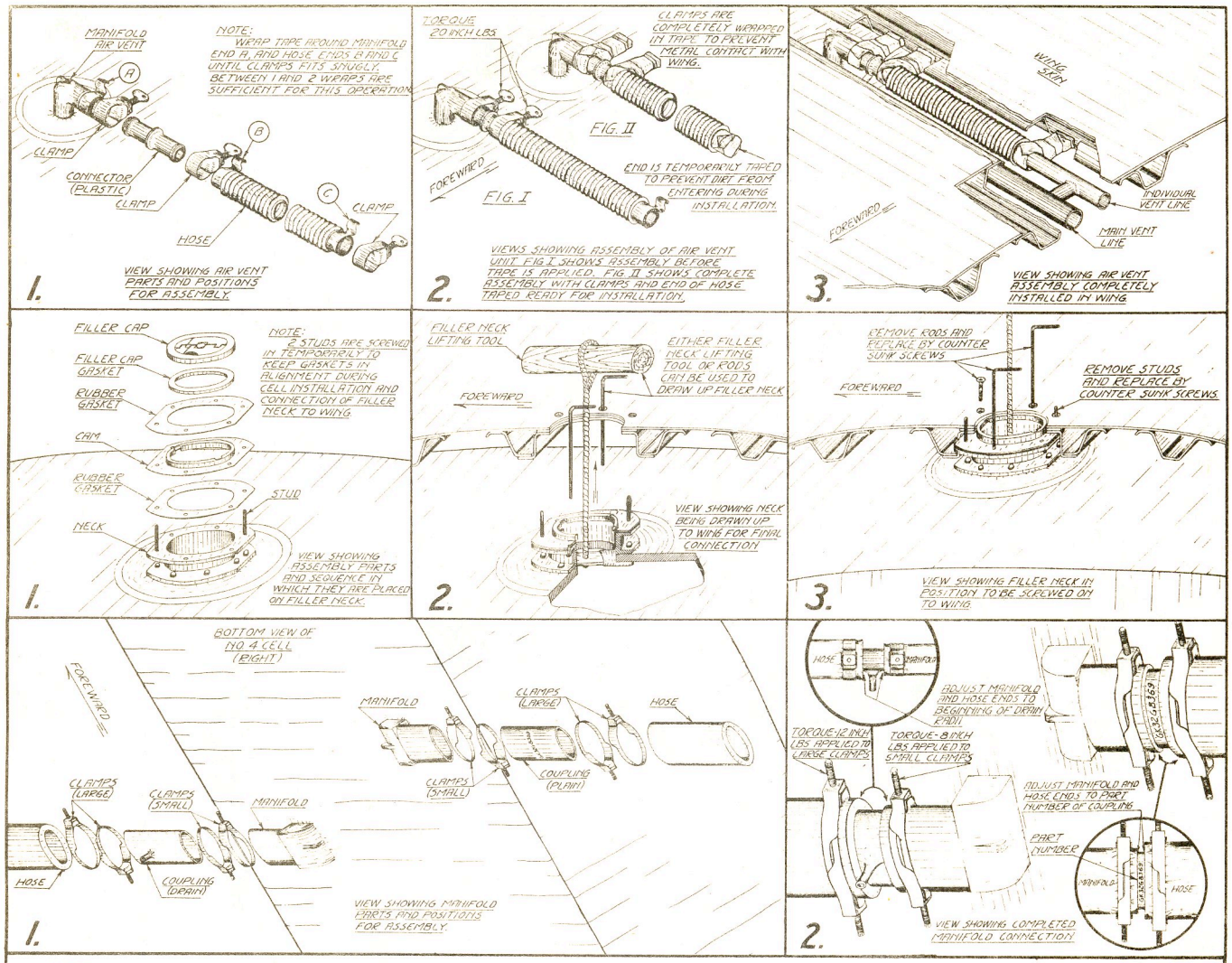


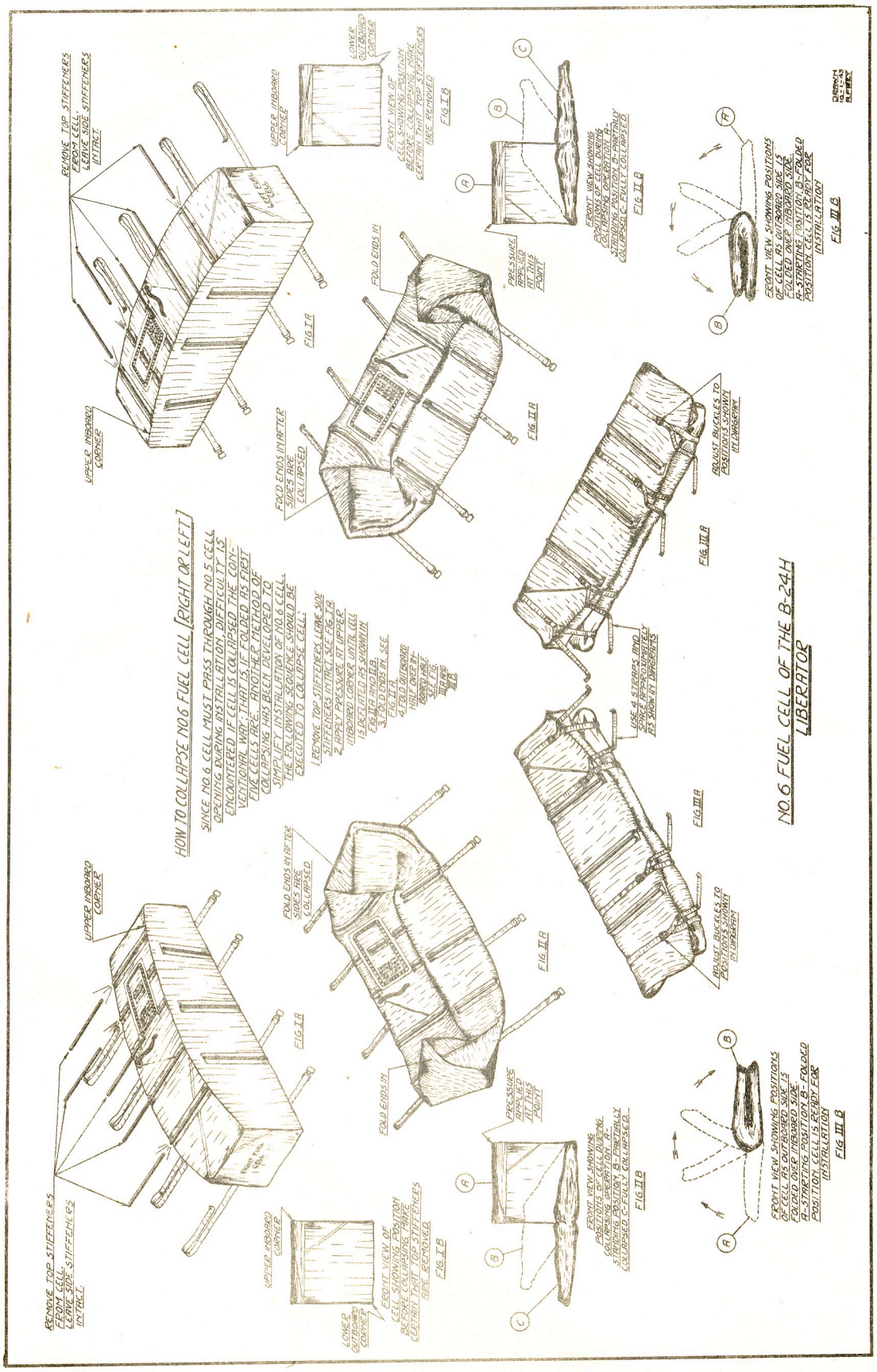
FUEL CELL CAPACITYS

NUMBER OF CELL	GOODYEAR CAPACITY IN GALLONS	FIRESTONE CAPACITY IN GALLONS
1	224	199
2	228	223
3	208	207
4	197	194
5	141	138
6	188	188
TOTAL	1186	1149

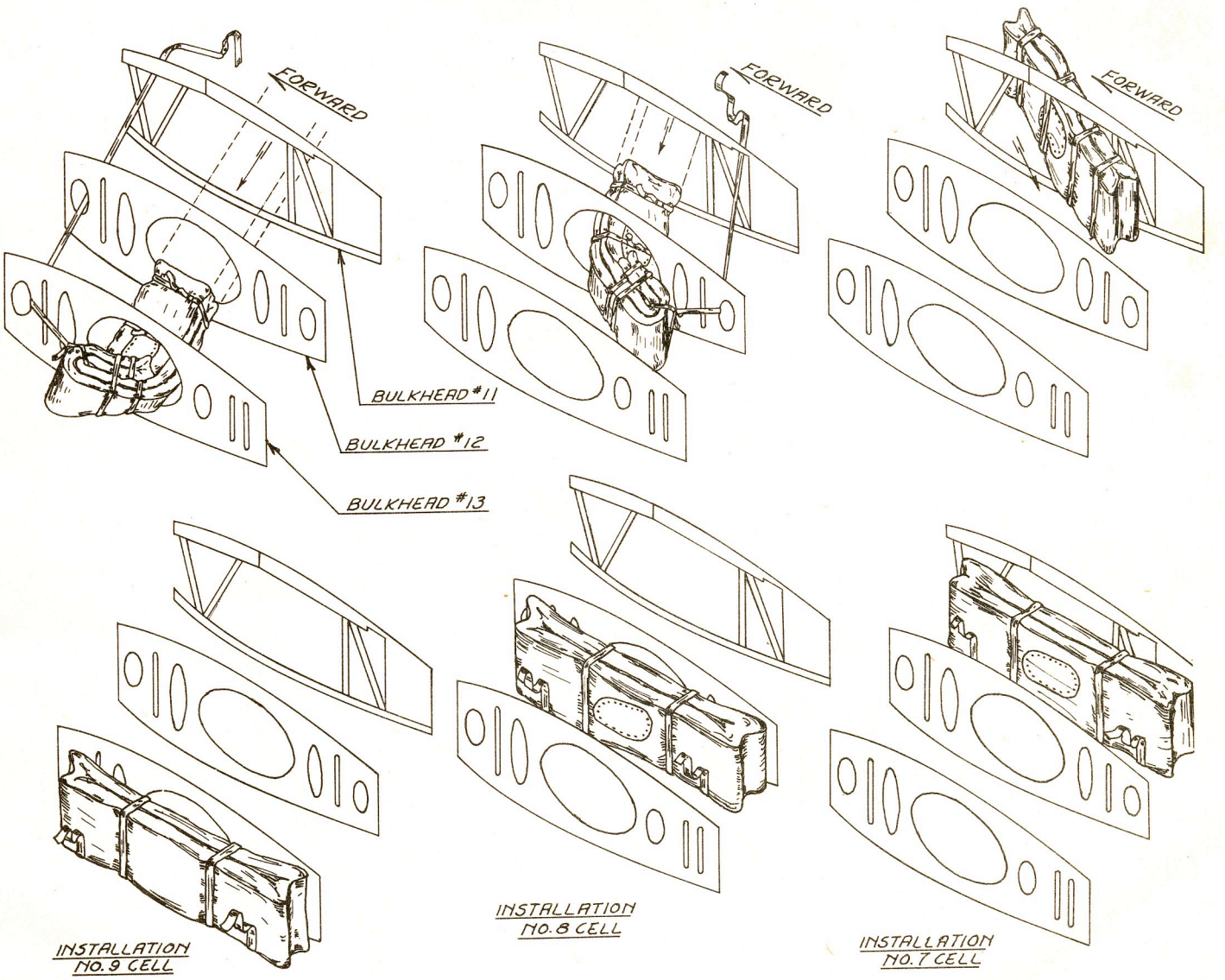
METHOD OF COLLAPSING AND INSTALLING MAIN WING CELLS CONSOLIDATED B-24

READ DIRECTIONS TOP TO BOTTOM


MANIFOLD AIR VENT
NOTE: WRAP TAPE AROUND MANIFOLD END A, AND HOSE ENDS B AND C UNTIL CLAMPS FITS SNUGLY. BETWEEN 1 AND 2 WRAPS ARE SUFFICIENT FOR THIS OPERATION
A
B
C
CLAMP
CONNECTOR (PLASTIC)
CLAMP
CLAMP
HOSE
1.
VIEW SHOWING AIR VENT PARTS AND POSITIONS FOR ASSEMBLY.
TORQUE 20 INCH LBS
CLAMPS ARE COMPLETELY WRAPPED IN TAPE TO PREVENT METAL CONTACT WITH WING.
FIG. II
END IS TEMPORARILY TAPED TO PREVENT DIRT FROM ENTERING DURING INSTALLATION.
FOREWARD
FIG. I
2.
VIEWS SHOWING ASSEMBLY OF AIR VENT UNIT FIG I SHOWS ASSEMBLY BEFORE TAPE IS APPLIED. FIG II SHOWS COMPLETE ASSEMBLY WITH CLAMPS AND END OF HOSE TAPED READY FOR INSTALLATION.
WING SKIN
INDIVIDUAL VENT LINE
MAIN VENT LINE
FOREWARD
3.
VIEW SHOWING AIR VENT ASSEMBLY COMPLETELY INSTALLED IN WING.
FILLER CAP
FILLER CAP GASKET
RUBBER GASKET
CAM
RUBBER GASKET
STUD
NECK
NOTE: 2 STUDS ARE SCREWED IN TEMPORARILY TO KEEP GASKETS IN ALIGNMENT DURING CELL INSTALLATION AND CONNECTION OF FILLER NECK TO WING.
1.
VIEW SHOWING ASSEMBLY PARTS AND SEQUENCE IN WHICH THEY ARE PLACED ON FILLER NECK.
FILLER NECK LIFTING TOOL
EITHER FILLER NECK LIFTING TOOL OR RODS CAN BE USED TO DRAW UP FILLER NECK
FOREWARD
VIEW SHOWING NECK BEING DRAWN UP TO WING FOR FINAL CONNECTION
2.
REMOVE RODS AND REPLACE BY COUNTER SUNK SCREWS
FOREWARD
REMOVE STUDS AND REPLACE BY COUNTER SUNK SCREWS.
3.
VIEW SHOWING FILLER NECK IN POSITION TO BE SCREWED ON TO WING.
BOTTOM VIEW OF NO. 4 CELL (RIGHT)
FOREWARD
CLAMPS (LARGE)
CLAMPS (SMALL)
MANIFOLD
HOSE
COUPLING (DRAIN)
MANIFOLD
CLAMPS (LARGE)
HOSE
CLAMPS (SMALL)
COUPLING (PLAIN)
1.
VIEW SHOWING MANIFOLD PARTS AND POSITIONS FOR ASSEMBLY.
HOSE
MANIFOLD
ADJUST MANIFOLD AND HOSE ENDS TO BEGINNING OF DRAIN END
TORQUE-12 INCH LBS APPLIED TO LARGE CLAMPS
TORQUE-8 INCH LBS APPLIED TO SMALL CLAMPS
ADJUST MANIFOLD AND HOSE ENDS TO PART NUMBER OF COUPLING
PART NUMBER
MANIFOLD
HOSE
2.
VIEW SHOWING COMPLETED MANIFOLD CONNECTION
NOTE: THE ABOVE INFORMATION CAN BE APPLIED TO OTHER CELLS. READ DIRECTIONS LEFT TO RIGHT.
METHODS OF INSTALLING NO. 4 RIGHT FUEL CELL AIR VENT, FILLER NECK AND MANIFOLD CONNECTIONS ON CONSOLIDATED B-24 H
DRAWN 1-1-43 R. FREY


NO. 6 FUEL CELL OF THE B-24H
LIBERATOR
HOW TO COLLAPSE NO 6 FUEL CELL [RIGHT OR LEFT]
SINCE NO. 6 CELL MUST PASS THROUGH NO 5 CELL OPENING DURING INSTALLATION, DIFFICULTY IS ENCOUNTERED IF CELL IS COLLAPSED THE CONVENTIONAL WAY. THAT IS IF FOLDED IN FIRST FIVE CELLS FIRST. ANOTHER METHOD OF COLLAPSING HAS BEEN DEVELOPED TO SIMPLIFY INSTALLATION OF NO. 6 CELL. THE NEW INSTALLATION OF NO. 6 CELL EXECUTED TO COLLAPSE CELL:
1. REMOVE TOP STIFFENERS, LEAVE SIDE STIFFENERS IN TACT. SEE FIG. I B
2. APPLY PRESSURE AT UPPER INBOARD CORNER UNTIL CELL IS DEFLATED AS SHOWN IN FIG. II A AND II B.
3. FOLD ENDS IN. SEE FIG. II A.
4. FOLD OUTBOARD HALF OVER IN-BOARD SEE FIG. III A AND III B
5. ADJUST BUCKLES TO POSITIONS SHOWN IN DIAGRAMS
6. USE 4 STRAPS AND SPARE BUCKLES AS SHOWN IN DIAGRAMS
REMOVE TOP STIFFENERS FROM CELL. LEAVE SIDE STIFFENERS INTACT
UPPER INBOARD CORNER
FIG. I A
LOWER OUTBOARD CORNER
UPPER INBOARD CORNER
FRONT VIEW OF CELL SHOWING POSITION BEFORE COLLAPSING PARTS CERTAIN THAT TOP STIFFENERS ARE REMOVED
FIG. I B
FOLD ENDS IN
FOLD ENDS IN AFTER SIDES ARE COLLAPSED
FIG. II A
PRESSURE APPLIED AT THIS POINT
FRONT VIEW SHOWING POSITIONS OF CELL DURING COLLAPSING OPERATION A-STRETCHING POSITION B-PARTIALLY COLLAPSED C-FULLY COLLAPSED
FIG. II B
ADJUST BUCKLES TO POSITIONS SHOWN IN DIAGRAM
FIG. III A
FRONT VIEW SHOWING POSITIONS OF CELL AS OUTBOARD SIDE IS FOLDED OVER INBOARD SIDE A-STRETCHING POSITION B-FOLDED POSITION, CELL IS READY FOR INSTALLATION
FIG. III B

INSTALLATION OF NO.'S 7, 8 & 9 OUTBOARD FUEL CELLS



NOTE: READ FROM TOP TO BOTTOM

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FUEL CELL QUESTIONS

1. What cells are connected by manifold hose to form the four main fuel systems? _____

_____

2. Where are the vents for the fuel cell system? _____

_____

3. Where are the booster pumps located? _____

_____ Sight gage fittings? _____

Transfer openings? _____

4. The manifold couplings with a drain are used where? _____

_____

5. Should the manifold coupling be attached to the manifold hose first or to the fuel cell pouch first? _____

6. What fuel cells take the short bellows hose? _____

7. Why should we disconnect the bellows hose at the fuel cell rather than at the wing upper surface when removing a fuel cell? _____

_____

8. Why should the bellows hose clamps be covered with tape? _____

_____

9. Why do we cover all openings on the fuel cell with tape during removal and installation? _____

10. What can be the effect of improper torque on the inspection door bolts?

_____

11. When is talc or powdered soapstone used on a fuel cell? _____

_____

12. When is it necessary to use a plywood shim on fuel cells? _____

_____

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13. Why do we work the stiffeners into place by groups rather than individually? _____

14. What may be used as a lubricant to aid in working the stiffeners in place? _____

15. What method is used to tie the stiffeners in? _____

16. Which of the cells cannot be removed or installed without first removing a truss brace in the bulkhead? _____

17. On what fuel cells are the side stiffeners removed and the top stiffeners left in for installation purposes? _____

18. On what fuel cell are the side stiffeners left in and the top stiffeners removed for installation purposes? _____

19. What is the maximum time a fuel cell should be left in a collapsed position? _____

20. When is it necessary to know the weight and capacity of a fuel cell? _____

21. In tightening manifold clamps, what is the minimum number of threads that should be left showing? _____

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QUESTIONS ON TIRE CHANGE AND INSPECTION

1. Why is a flexible valve stem used on nose wheel tires?_____

_____

_____

2. What is the correct procedure for inflating and deflating nose wheel tires?

_____

_____

_____

3. Is it permissable to use a lubricant on nose wheel tires?_____

4. How is pressure checked on main landing gear tires?_____

_____

_____

5. What method is used to clean tire and tube of nose wheel_____

_____

_____

6. Explain the visual means for detecting tire slippage on tires_____

_____

7. How are slippage marks on tires & tubes made use of when installing?

_____

_____

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INTERCHANGEABILITY QUESTIONS

1. What is the T.O. number of Interchangeability Cross Reference Charts?

_____

2. What information on the various parts can be found in these charts?

_____

_____

3. What is the meaning of the red lines in the charts? _____

_____

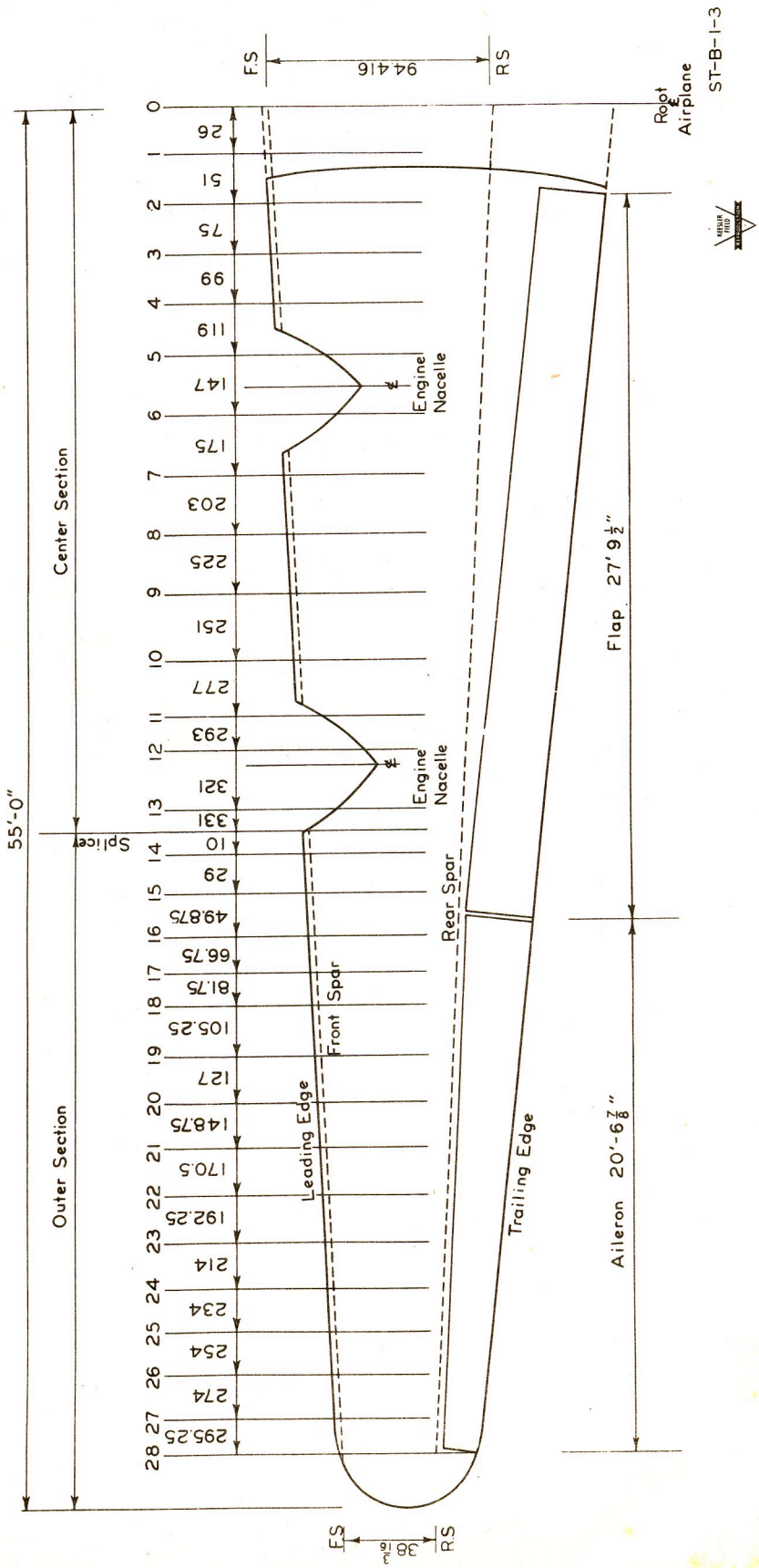
4. What does an asterisk indicate? _____

_____

5. What is the purpose of the remarks column? _____

_____

WING STATION DIAGRAM
B-24D
NOVEMBER 1, 1942



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GENERAL PROCEDURE TO BE FOLLOWED WHEN REMOVING OR INSTALLING REMOVABLE SURFACES

Removal of Vertical Surfaces:

1. Loosen all bolts.
2. Remove center hinge bolts.
3. Remove bottom hinge bolt.
4. Remove top hinge bolt LAST.

Installation of Vertical Surfaces:

1. Start bolt in top hinge FIRST. (Do not tighten)
2. Start bolt in bottom hinge.
3. Start remaining hinge bolts.
4. Tighten all bolts USING TORQUE WRENCH. (See table below)

Removal of Horizontal Surfaces:

1. Loosen all hinge bolts.
2. Remove center hinge bolts.
3. Remove inboard and outboard at the same time. LAST.

Installation of Horizontal Surfaces:

1. Loosen all hinge bolts.
2. Remove center hinge bolts.
3. Remove inboard and outboard at the same time. LAST.

Installation of Horizontal Surfaces:

1. Start bolts in inboard and outboard hinge at the same time.
2. Start center hinge bolts.
3. Tighten all bolts USING TORQUE. (See table below).

TORQUE WRENCH TABLE

SIZE	STEEL IN. LBS.	AL. IN. LBS.	STEEL FT. LBS.	AL. FT. LBS.
3/16"	35-50	10-14	3-4	1
1/4	55-90	20-35	5-7	2-3
5/16"	90-150	50-75	8-12	4-6
3/8"	200-350	80-110	17-29	7-9
7/16"	350-600	100-140	30-50	9-11
1/2"	500-850		42-70	14-22
5/8"	850-1300	400-460	71-108	29-38
3/4"	1200-1750		240	

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Cable Tensions

Cable tensions are taken are taken with a cable tension indicator (tensiometer).

This cable tension indicator is not used on non-flexible cable nor should it be used within a foot from pulleys or fairleads. Use on non-flexible cable gives extremely high readings.

Non-flexible cable is used in the elevator and rudder systems through bomb bays. Aileron control cables are non-flexible back of the wing rear spar.

System	Code	Tension
Aileron	White	60# - 0 + 10#
Elevators	Yellow	75# + or - 5#
Rudder	Green	60# - 0 + 10#
Tabs	(As above)	35#
Lock	Blue	40#
Flaps	None	150# to 200#
A-5 Manual Emergency release) Bomb bay door)	None	

Following is the color code for the identification of surface control cables. Each fitting is marked with 1/2" color bands as noted:

Left Aileron Up	White
Left Aileron Down	White & Black
Aileron Trim Tab Up	Black - White
Aileron Trim Tab Down	White
Elevator Up	Yellow
Elevator Down	Yellow & Black
Elevator Trim Down Tab Up	Black & Yellow
Elevator Trim Up Tab Down	Yellow
Rudder Right	Green
Rudder Left	Green & Black
Rudder Trim Tab Right	Black & Green
Rudder Trim Tab Left	Green
Flare Release Cables	Blue -Yellow -Blue

STRUCTURE

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Lock	Surface	Blue
Unlock	Surface	Blue & Black
Brake Lock		Red
Brake Release		Red & Black

TABS - REMOVAL AND INSTALLATION

Tools: 3/8" combination wrench, 5" screwdriver, 7/16" combination wrench, diagonal cutters, and cotter pins.

Removal:
1. Disconnect bonding wire (if present on tab).
2. Remove bolt which attaches tab push-pull tube to tab horn.
3. Remove screws attaching tab hinge to tab spar.

Note: Do not remove hinge pin from tab hinge.

Installation:
1. Lock primary surface (rudder, elevator, or aileron) in neutral. This prevents servo action.
2. Insert screws attaching tab hinge to tab spar.
3. Line up tab in neutral position to primary surface and attach bolt between tab push-pull tube and tab horn. If necessary, align to neutral by screwing bearing head (rod end) in or out of push-pull tube, adjusting the length.
4. Connect bonding wire (if present on tab).
5. Safety bolt at tab horn with cotter pin.

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RIGGING TABS ON B-24E

To Rig Aileron Tab at Aileron:

1. Set tab in neutral with joint of push-pull tube even with the aileron hinge line. See Figure II (1).
2. With aileron tab neutral, see that the tab chain ends are even. See Figure II (2).
3. Check all tab connections and see that the bolts are tight and keyed.
4. See that the push-pull tube, both ends are "in safe" and that all lock-nuts are tight.
5. Check tab sprocket bearing for end play. End play must be removed from this unit as it will cause the tab to flutter in flight.

To Rig Aileron System After Rigging Tab at Aileron:

1. With aileron tab in neutral, the following positions must be held:
   a. Turnbuckle barrels even between Station 3.0 and 4.1 (See Figure I (1).).
   b. Retaining screw in drum at pedestal - on top - dead center.
   c. Indicator at pedestal reading zero.
2. See that cable stops at Station 4.1 are set and tightened to 10 degrees of travel both ways to tab on aileron. See Figure III (1).
3. Disregard the reading for full travel on the dial at the pedestal.
4. See that all turnbuckles are safetied with 1035 stainless steel safety wire not less than five wraps and not more than eight wraps.
5. See that all pulleys are aligned.
6. See that all pulley axle bolts are tight and keyed.
7. See that all cables are clear and safe.
8. The cable tension is to be approximately 35 pounds at 70 degrees.

To Rig Rudder Tab at Rudders:

1. The joint of the tab-push-pull tube must be even with the hinge line of the rudder. Then the tab surface trailing edge is set even with the trailing edge of rudder for neutral position. Adjustment of tab is made at the push-pull tube attached to the tab. See Figure V (1).
2. Rudder tabs are to be "in safe" at both ends and lock nuts tight See Figure V (2).
3. See that all rudder tab torque shaft connection bolts are tight and cotter keyed.
4. See that all clearances to push-pull tubes and torque shaft are clear and safe.
5. All clearances to push-pull tubes and torque shaft should be 1/8 inch through all webs.

To Rig Rudder System After Rigging Tabs at Rudders:

1. With rudder tab surface trailing edge even with rudder trailing edge for neutral position, the following positions must be held:
   a. Tab chain in stabilizer with ends even. See Figure V (3).
   b. Turnbuckles even between Station 3.0 and 4.1 See Figure IV (1).
   c. Cable retaining screw on drum in pedestal straight forward.
   d. Indicator at pedestal reading zero.

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~~RIGGING TABS CONT'D~~

To Rig Rudder System After Rigging Tabs at Rudders: (Cont.)

2. See that all pulley axle bolts are tight and keyed.
3. See that all pulleys are aligned.
4. See that all pulley anchor bolts are tight and keyed.
5. Set cable stops and tighten at Station 4.1 to 10 degrees of travel both ways of tab at tail. See Figure III (1).
6. Disregard readings of indicator dial at pedestal for full travel as the readings on indicator dial are not correct.
7. Cable tension is taken at approximately 35 pounds at 70 degrees.
8. All turnbuckles are to be safetied with .035 stainless steel safety wire, not less than five wraps and not more than eight wraps.
9. All turnbuckle barrels are to be adjusted evenly at both ends.

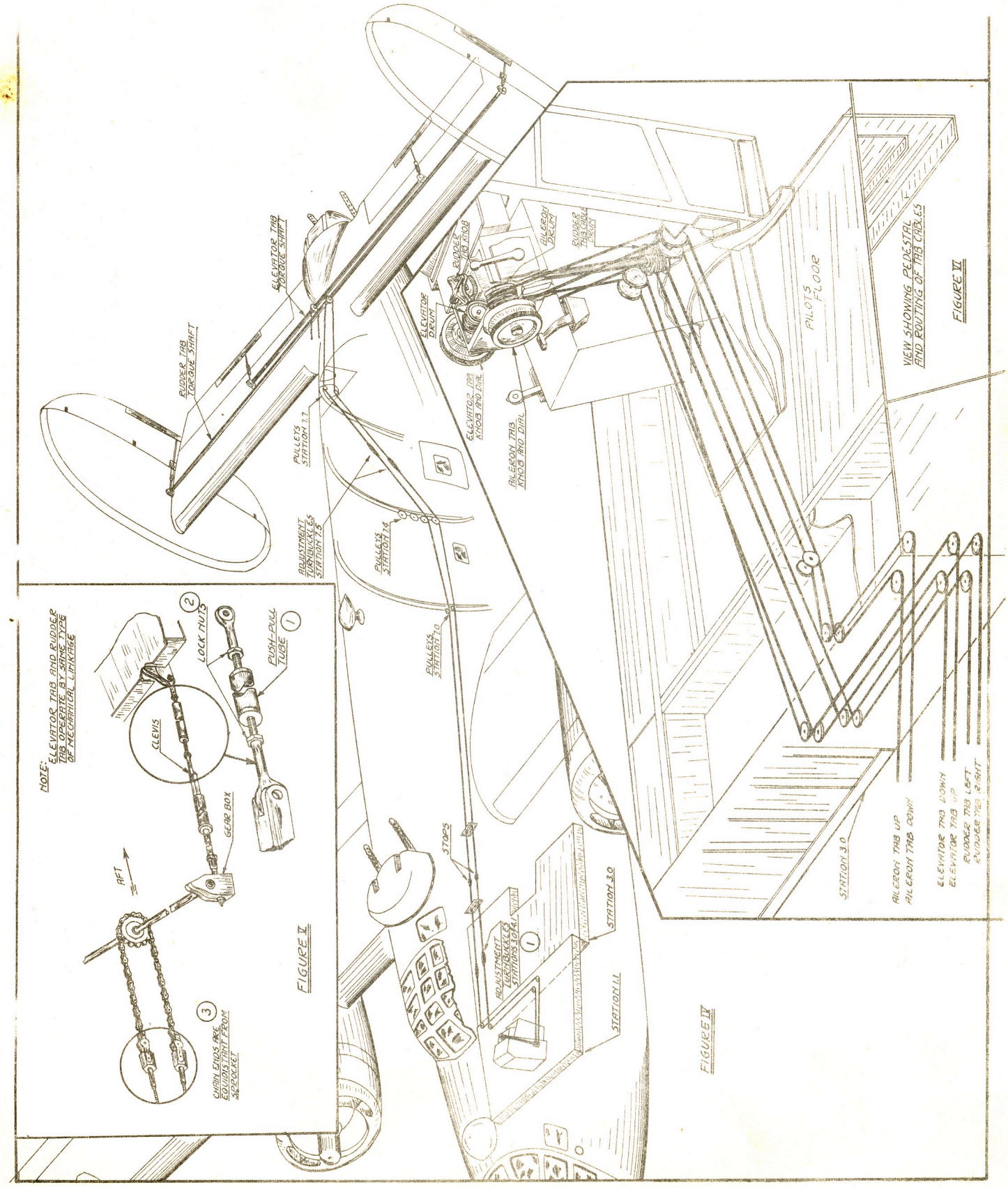
To Rig Elevator Tab at Elevators:

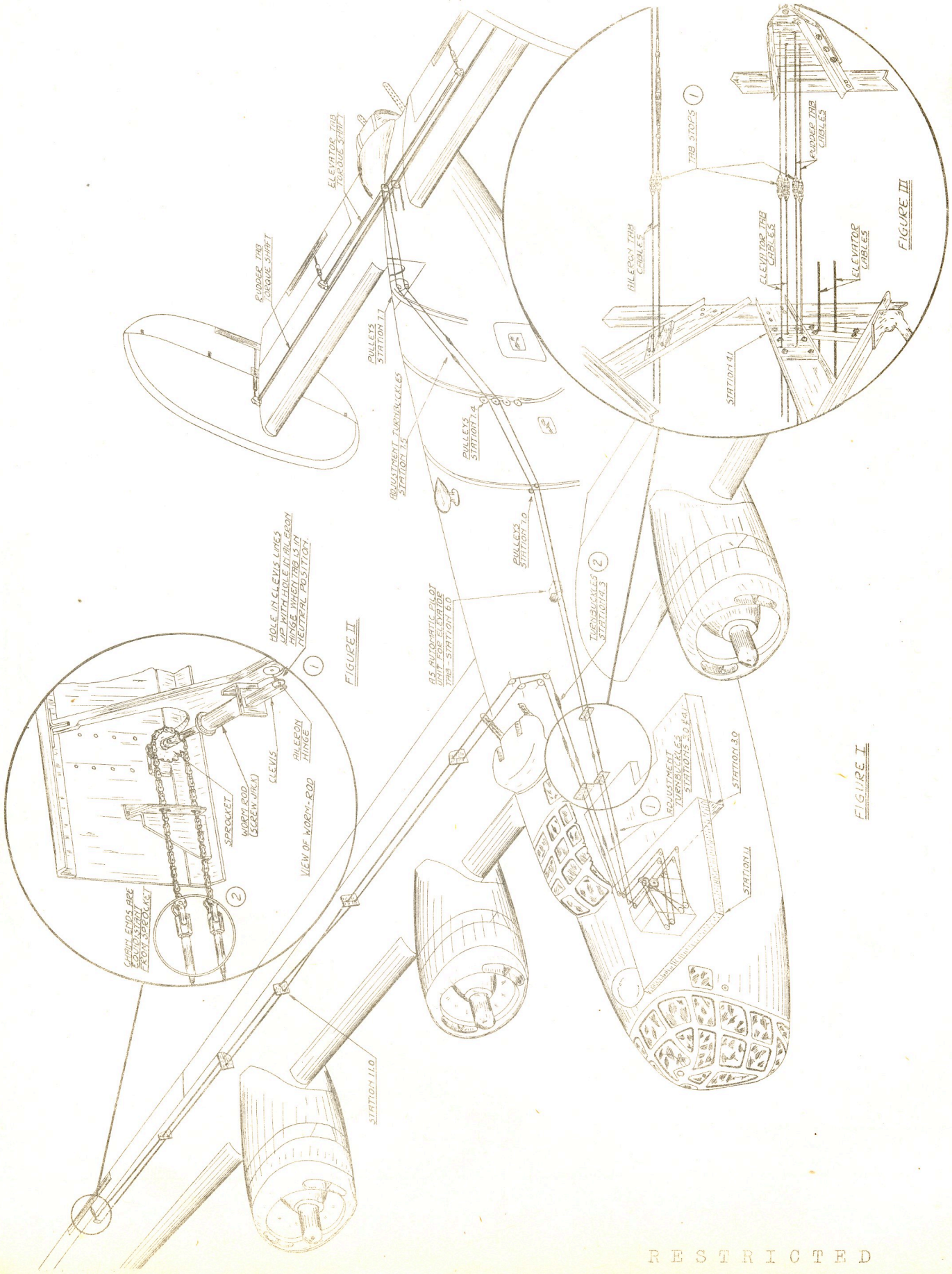
1. With joint of tab push-pull tab even with elevator hinge line "right and left", the tabs are to be set with the elevator trailing edge for neutral, by adjusting the push-pull tube connected to the tab. See Figure V.
2. After adjustment, see that both ends of the push-pull tube are "in safe".
3. See that lock nuts at both ends of push-pull tube are tight. See Figure V (2).
4. All bolt connections of elevator torque shafts are to be tight and keyed with the exception of the torque shaft connecting to the gear boxes, right and left, which are to be just snug - to allow for flexibility in flight.

To Rig Elevator System After Rigging Tabs at Elevators:

1. With elevator tab surfaces trailing edge even with elevator trailing edge for neutral position, the following positions must be held:
   a. Tab chain in stabilizing with ends even. See Figure V (3).
   b. Turnbuckle barrels even between Station 3.0 and 4.1 See Figure I (1).
   c. Cable retaining screw in drum at pedestal - on top - dead center.
   d. Indicator at pedestal reading zero.
2. Set cable stops and tighten at Station 4.1 for 10 degrees travel each way to tab at elevators. See Figure III (1).
3. Disregard readings on indicator at pedestal for full travel.
4. Cable tension is to be approximately 35 pounds at 70 degrees.
5. All turnbuckles are to be safetied with .035 stainless steel safety wire. All turnbuckle barrels are to be adjusted evenly at both ends.
6. See that all pulley bolts are tight and keyed.
7. See that all pulleys are aligned.
8. See that all pulley brackets and bolts are tight and keyed.

Only 3/32 (7 x 7) flexible cable used.


ELEVATOR TAB TORQUE SHAFT
RUDDER TAB TORQUE SHAFT
PULLEYS STATION 1.1
ADJUSTMENT TURNBUCKLE STATION 1.5
PULLEYS STATION 1.4
PULLEYS STATION 1.0
STOPS
ADJUSTMENT TURNBUCKLE STATION 3.0
STATION 3.0
STATION 1.1
ELEVATOR DRUM
ELEVATOR TAB KNOB AND DIAL
RUDDER TAB KNOB
AILERON DRUM
RUDDER TAB KNOB AND DIAL
AILERON TAB KNOB AND DIAL
PILOTS FLOOR
VIEW SHOWING PEDESTAL AND ROUTING OF TAB CABLES
FIGURE VI
STATION 3.0
AILERON TAB UP
AILERON TAB DOWN
ELEVATOR TAB DOWN
ELEVATOR TAB UP
RUDDER TAB LEFT
RUDDER TAB RIGHT
FIGURE IV
NOTE: ELEVATOR TAB AND RUDDER TAB OPERATE BY SAME TYPE OF MECHANICAL LINKAGE
LOCK NUTS
PUSH-PULL TUBE
CLEVIS
GEAR BOX
AFT
CHAIN ENDS ARE EQUIDISTANT FROM SPROCKET
FIGURE V


ELEVATOR TAB TORQUE SHAFT
RUDDER TAB TORQUE SHAFT
PULLEYS STATION 7.7
ADJUSTMENT TURNBUCKLES STATION 7.5
PULLEYS STATION 7.4
PULLEYS STATION 7.0
TURNBUCKLES STATION 4.3
AIL AUTOMATIC PILOT UNIT FOR ELEVATOR TAB - STATION 6.0
ADJUSTMENT TURNBUCKLES STATIONS 2.0 & 4.1
STATION 3.9
STATION 1.1
STATION 11.0
HOLE IN CLEVIS LINES UP WITH HOLE IN AILERON HINGE WHEN TAB IS IN NEUTRAL POSITION
CLEVIS
AILERON HINGE
SPROCKET
WORM ROD (SCREW JACK)
VIEW OF WORM-ROD
CHAIN ENDS ARE EQUIDISTANT FROM SPROCKET
FIGURE II
TAB STOPS
AILERON TAB CABLES
ELEVATOR TAB CABLES
RUDDER TAB CABLES
ELEVATOR CABLES
STATION 4.1
FIGURE III
FIGURE I

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RIGGING THE LOCK ON THE B-24 - E

Check the lock unit in the horizontal stabilizer to see if the rudder rack leaves the casting 1/4" ahead of the elevator rack. See Figure V.

Put 3½ wraps of cable on the drum in the tail locking unit, Figure IV, and with the terminal on the lock cable in front of station 7.3, 4½ inches ahead of the fair-lead (see Figure I - (1)), stake the second cable from the right of the drum. The staking bolt should be on the aft side of the drum in the unlocked position. See Figure IV- (1).

Tighten the turnbuckles in the aft compartment, See Figure I - (2), approximately twelve threads inside of the barrel.

Check the lock handle in the pedestal for 1½ wraps of cable, see Figure VI - (1), and connect the cables in the bomb bay and apply tension on them. See Figure I - (3).

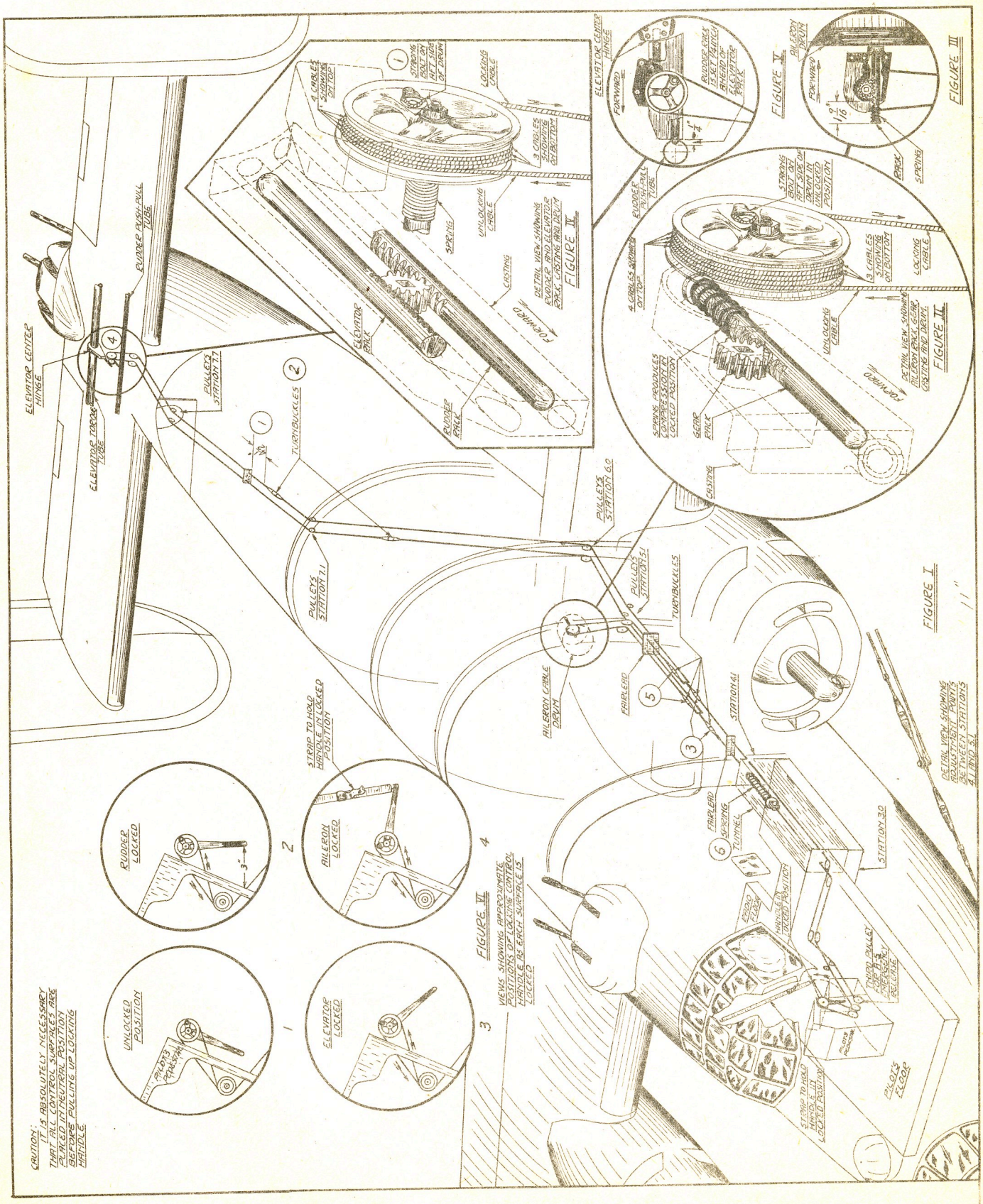
With the rudders out of neutral slip the cable on the lock handle drum until handle can be pulled up approximately 3 inches, see Figure VI - (2), before the rudder rack strikes the rudder push-pull tube in the tail. See Figure I - (4). (This is the amount of safety it has.)

Mark the left hand cable on the lock handle cable drum at the skating slot. Disconnect the cables in the bomb bay, see Figure I - (3), remove the handle and stake the cable on the mark. Connect the cables again and put tension on them and by adjusting the turnbuckles rig the handle to 3 inches safety.

With lock handle in unlocked position, put 3½ wraps of cable on the aileron lock drum and connect them to the main cables. See Figure I - (5). Tighten the turnbuckles evenly to where they are not slack. Then slip the cable around the drum until the aileron rack extends 1-9/16" from castings. See Figure III. Mark the second cable from the right over the staking slot and stake it like the tail lock. Then tighten the turnbuckles until tension is right on the cables and the measurement on the aileron rack is 1-9/16". Pull the lock handle all the way up against the casting with the controls in neutral. When the handle is up tightly, the spring on the aileron lock rack should be completely compressed and the lock cable slightly tighter than the unlock cable.

Set the spring at Station 4.1, see Figure I - (6), so the tube sticks through one inch with the lock handle all the way down. Then with the controls in neutral and the lock handle strapped all the way up, see Figure VI - (4), put enough tension on the cables to keep too much slack out of the unlock cable between Station 3.0 and 4.1. When this is completed safety wire all turnbuckles in both locked and unlocked position to be sure it is winging free and safe. NOTE: All drums are wrapped so that the lock cable runs off the left aft side of the drum.

The tension on the lock cables will be from 40 to 60 pounds in the front bomb bay forward of where the aileron lock cables start. In the rear compartment the tension will be approximately one-half this amount. Keep the tension as low as possible and still keep the slack out of the unlock cable forward of the unlock sprint.


CAUTION:
IT IS ABSOLUTELY NECESSARY THAT ALL CONTROL SURFACES ARE IN NEUTRAL POSITION BEFORE PULLING UP LOCKING HANDLE
UNLOCKED POSITION
PILOTS PEDESTAL
RUDDER LOCKED
ELEVATOR LOCKED
ALLERON LOCKED
STRAP TO HOLD HANDLE IN LOCKED POSITION
FIGURE VI
VIEWS SHOWING APPROXIMATE POSITIONS OF LOCKING CONTROL HANDLE IN EACH SURFACE IS LOCKED
ELEVATOR CENTER HINGE
ELEVATOR TORQUE TUBE
RUDDER PUSH-PULL TUBE
PULLEYS STATION 7.7
TURNBUCKLES
PULLEYS STATION 7.1
ELEVATOR PACK
RUDDER PACK
STRONG BOLT ON AFT SIDE OF DRUM
4 CABLES SHOWING OFF TOP
LOCKING CABLE
3 CABLES SHOWING OFF BOTTOM
UNLOCKING CABLE
SPRING
CASTING
FORWARD
DETAIL VIEW SHOWING RUDDER AND ELEVATOR PACK, CASTING AND DRUM
FIGURE II
ELEVATOR CENTER HINGE
FORWARD
RUDDER PUSH-PULL TUBE
RUDDER CABLE IS SET PARALLEL AHEAD OF ELEVATOR PACK
FIGURE V
ALLERON DRUM
FORWARD
PACK
SPRING
FIGURE III
STRONG BOLT ON AFT SIDE OF DRUM IN LOCKED POSITION
4 CABLES SHOWING OFF TOP
3 CABLES SHOWING OFF BOTTOM
LOCKING CABLE
UNLOCKING CABLE
SPRING PROVIDES CONTRACTS SLOTS IN LOCKED POSITION
GEAR PACK
CASTING
FORWARD
DETAIL VIEW SHOWING AILERON PACK, GEAR, CASTING AND DRUM
FIGURE IV
PULLEYS STATION 6.0
PULLEYS STATION 5.1
TURNBUCKLES
AILERON CABLE DRUM
FORWARD
STATION 4.1
SPRING
TUNNEL
FORWARD
STATION 3.0
FOOD FLOOR
HANDLE IN LOCKED POSITION
TOWER PULLEY
PILOTS FLOOR
STRAP TO HOLD HANDLE IN LOCKED POSITION
PILOTS FLOOR
FIGURE I
DETAIL VIEW SHOWING ADJUSTABLE POINTS BETWEEN STATIONS 4.1 AND 5.1

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AILERON - REMOVAL AND INSTALLATION

Tools: 3/8" socket, ratchet, 7/16" combination wrench, 3/8" combination wrench, thin lip offset screwdriver, 5" screwdriver, 7/16" deep socket diagonal cutters.

Removal:
1. Disconnect bonding wire.
2. On right aileron only, remove bolt attaching tabe push-pull tube to horn.
3. Detach connecting link of gear box lever arms from aileron, one at each arm.
4. Remove hinge access plates on bottom side of aileron.
5. Loosen all hinge bolts.
6. Remove center hinge bolts FIRST, then inboard and outboard hinge bolts LAST and together.
7. Slide aft until clear of brackets.

Installation:
1. Reverse steps of removal, starting inboard and outboard hinge bolts FIRST.

   Caution: Do not tighten any of the hinge bolts until all have been inserted.

2. If tab is out of neutral when control at pedestal reads zero, make adjustments as given under TAB INSTALLATION.
3. Safety all bolts with cotter pins.

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RIGGING AILERONS ON B-24-E

Control Column - Figure II. With arrow on Right and Left control wheels (1) pointing downward, set stop blocks on cross-over chain exactly in the middle of the stop box (2).

Lock the aileron control drum, Figure I - (1) on the center section spar with the controls lock.

With the drum locked connect cables from drum to control chain, leading from left control unit, and adjust turnbuckles, Figure I - (2), located between Station 3 and 4 so that arrows on the control wheels point exactly vertically downward with cable tension as per table below.

Connect cables (3) between inner (4) and outer (5) gear boxes. With the lower cable loose, take up the back lash with the upper cable. (6) Snug lower cable (7). This adjustment is important. If BACK LASH is not taken out ailerons will flutter. If cables are TOO TIGHT, gear boxes will be distorted and ailerons will bind. The upper cable should be slightly tighter than the lower.

With the drum still locked, clamp ailerons so that there is 1/2 inch droop in the ailerons measured between trailing edge of aileron and wing. See Figure III. Connect cables, Figure I - (8), between inboard gear boxes and main operating drum on center section. Adjust evenly until tension of all four cables reaches that prescribed in the table below.

It is important, for proper adjustment, of the controls that ailerons be rigged to the following tensions at 70° F., 21.1° C. temperature:

Main Cables in Fuselage	60 lbs. minus 0 plus 10
Main Cables in Each Wing	60 lbs. minus 0 plus 10
Gear Box Connection Cable	No play
Cross-over Chains at Control Unit	No play

Aileron stops Figure II are set for 20° Aileron Throw.

Both extra flexible 3/16 (7 x 19) and non-flexible 3/16 (1 x 19) are used.

Color Code: Right wing up - White.
Right wing down - White and black.

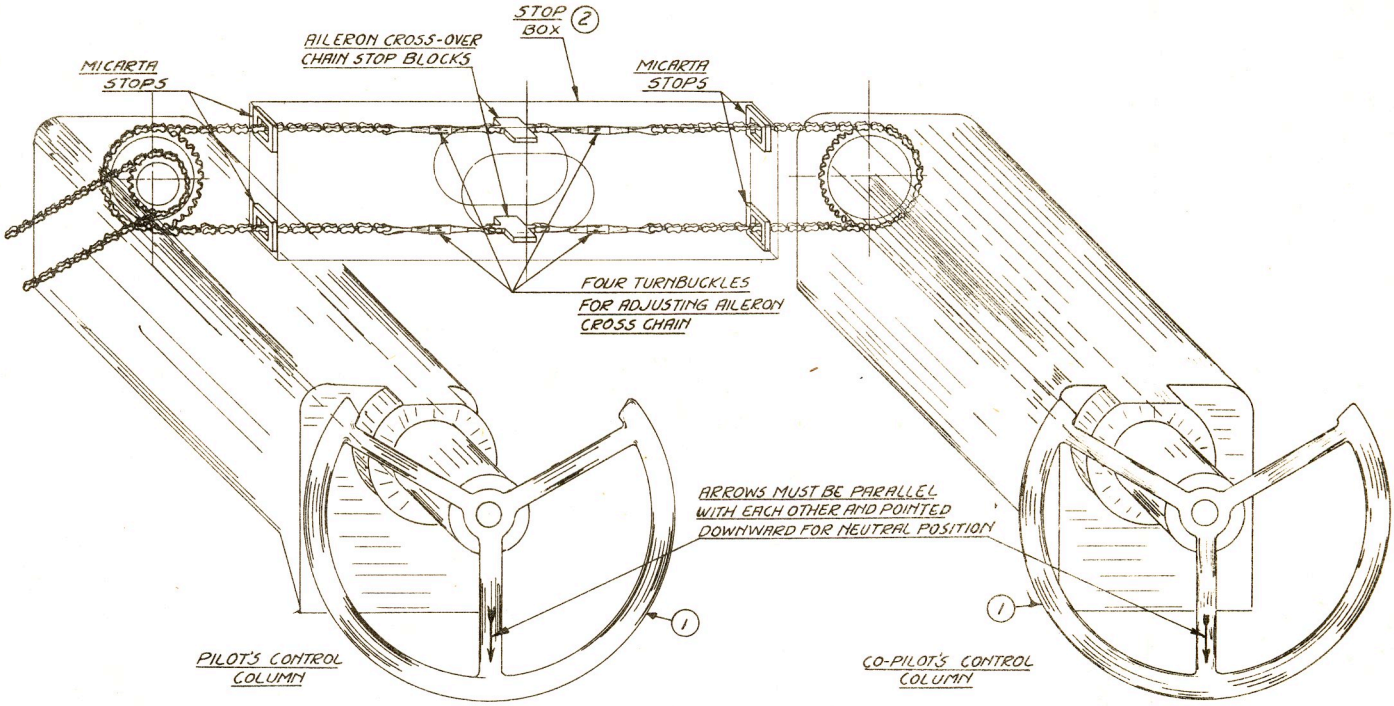
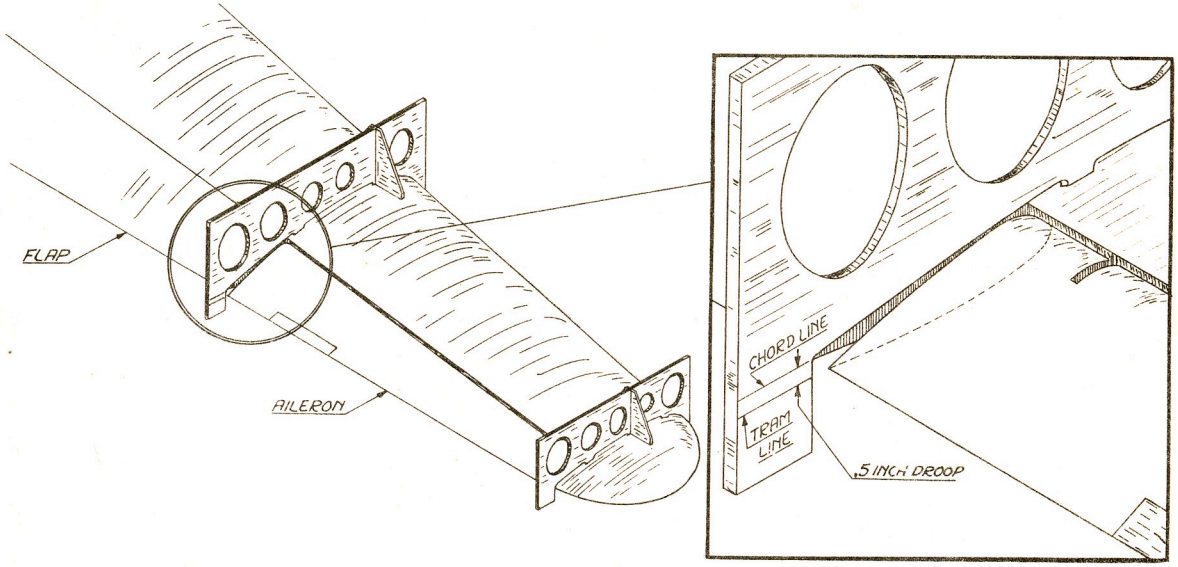


FIGURE 2



DETAIL VIEW SHOWING AILERON RIGGED TO .5 INCH DROOP

FIGURE 3

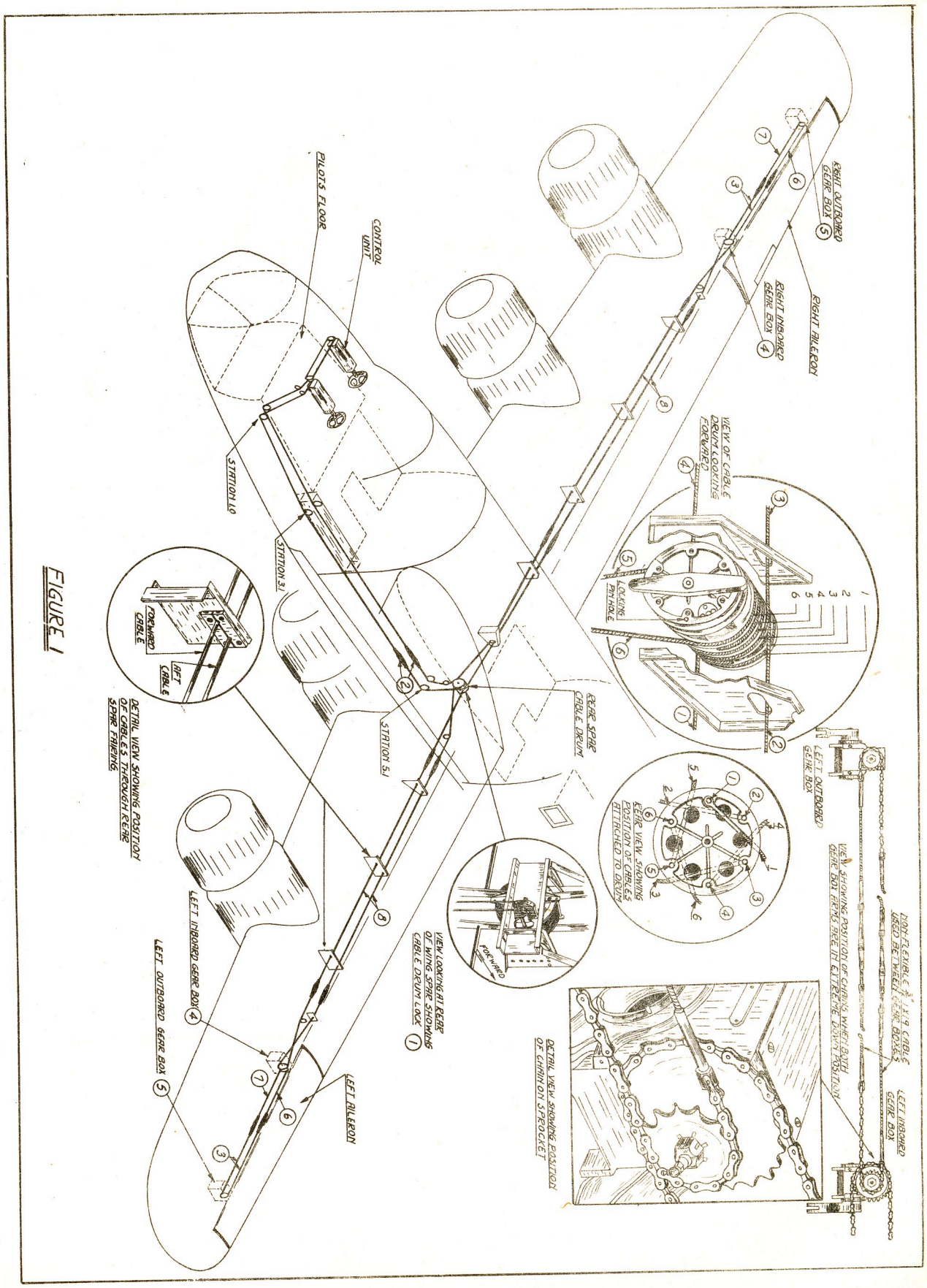

RIGHT OUTBOARD GEAR BOX 5
RIGHT INBOARD GEAR BOX 4
RIGHT AILERON
PILOTS FLOOR
CONTROL UNIT
STATION 10
STATION 3.1
STATION 5.1
VIEW OF CABLE DRUM LOOKING FORWARD
LOCKING PIN HOLE
1 2 3 4 5 6
REAR SPAR CABLE DRUM
REAR VIEW SHOWING POSITION OF CABLES ATTACHED TO DRUM
LEFT OUTBOARD GEAR BOX
VIEW SHOWING POSITION OF CHAINS WHEN BOTH GEAR BOX ARMS ARE IN EXTREME DOWN POSITION
NON-FLEXIBLE 3/16" LEVER CABLE USED BETWEEN GEAR BOXES
LEFT INBOARD GEAR BOX
FORWARD
VIEW LOOKING AT REAR OF WING SPAR SHOWING CABLE DRUM LOCK 1
DETAIL VIEW SHOWING POSITION OF CHAIN ON SPROCKET
FORWARD CABLE
AFT CABLE
DETAIL VIEW SHOWING POSITION OF CABLES THROUGH REAR SPAR FAIRING
LEFT INBOARD GEAR BOX 4
LEFT OUTBOARD GEAR BOX 5
LEFT AILERON

FIGURE 1

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AILERON QUESTIONS

1. How does one gain access to the aileron gear boxes and crossover turnbuckles?

2. What is inspected through the access doors on the bottom surface of the aileron?

3. Why can't the ailerons be interchanged?

4. List, briefly, the main steps in removing an aileron.

5. Before installing an aileron, how can we check to make certain that the hinge brackets are properly aligned?

6. Should the aileron be streamlined with the wing when the drum is locked and the plane is on the ground? Why?

7. If an aileron is not in its proper position when the drum is locked, how can we make the necessary adjustment?

8. What is the maximum aileron tab trim adjustment allowed for the Army acceptance flight inspection (at the factory)? Where can we look for trouble if this is exceeded?

9. What causes aileron control wheels to move together? How far do they turn each way?

10. What is the position of the aileron control wheels when the aileron control system is properly locked in neutral? What is the correct position of the stops at this neutral position?

11. How can we adjust an aileron control wheel if it is not properly aligned to neutral, or if the stops do not hit simultaneously?

12. What prevents the cables from slipping on the aileron cable drum?

13. How do we remove backlash from the aileron gear boxes?

14. Briefly, trace the aileron cables from control columns to gear boxes. What causes one aileron to go up when the other goes down?

Airplane & Engine Mech Course (Special B-24)
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WING FLAPS - REMOVAL AND INSTALLATION

Tools: 7/16" combination wrench, 3/8" combination wrench, 5" screwdriver, 9/16" combination wrench.

Removal:
1. Lower the flaps until they are fully extended.
2. Loosen turnbuckles on all extending cables.
3. Disconnect extending cables and tape them to the ribs of trailing edge of wing.
4. Disconnect retracting cables and also tape to ribs.
5. Remove pulleys.
6. Remove stops at aft end of each track. Be sure to remove the extreme outboard and inboard stops last.
7. Slide flap aft and down until free of tracks.

Installation:
1. If installing a new flap which has not previously been lined up to the tracks on the ship, each track should be removed and lined up to the carriage station which it supports. All these tracks can be removed with bolts.
2. Bolt the tracks back to the track supports.
3. Adjust the inboard and outboard track top brace so that these tracks will be flush with the trailing edge of the wing.
4. Set up a guide wire between the inboard and outboard tracks at the aft lower edge of the tracks, then adjust the three remaining tracks so that they will coincide with this guide wire. Lock this adjustment on the track braces. Remove the guide wire.
5. Insert the flap.
6. Adjust the position of the center track, centering it to the flap vertical and horizontal rollers in the up and down position.
7. Adjust remaining tracks to center at this position and attach them to trailing edge of wing.
8. Attach extension stops at aft end of tracks.
9. Install pulleys.
10. Attach extending and retracting cables to flap.
11. By tightening a turnbuckle on a retracting cable and loosening a turnbuckle on the corresponding extending cable, or vice versa, adjust the extreme retracted or extended position of the flap to give proper cushion and clearance fore and aft with the corresponding proper position of the hydraulic jack.
12. Adjust tension on cables(150 to 200 lbs.) safety turnbuckles and safety bolts with cotter pins.

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RIGGING THE FLAPS ON THE B-24E LIBERATOR

Tighten all turnbuckles evenly until approximate operating tension is obtained.

Check all pulleys for alignment with cables and check to see that cables are not fouled or crossed at rear spar.

Extend the flaps fully so the back rollers touch the "down" stops. Then retract them 1/8" (see Figure IV - (1)), by letting out on the extending cables and taking up on the retracting cables.

A metal "horseshoe" gage (.064, approximately 1/16") is placed on the shaft of the hydraulic jack. See Figure III - (1). This is the safety for the jack at "in" position. See Figure III - (2).

Then bring the flaps to a full retracted position. Check the four rubber "up" stops by inserting a .025" feeler gage between them and the forward flap rollers. See Figure V - (1). For the correct measurement the gage should remain there firmly.

If the flap roller is against the "up" stop and preventing the insertion of the feeler gage, loosen the retracting cables and tighten the extending cables affecting that stop.

If the feeler gage falls out when inserted, the extending cables should be loosened and the retracting cables tightened affecting that stop. This operation is repeated until a drag is felt on feeler gage when it is pulled out.

After tension and operation of the entire system is satisfactory, operate flaps and check closely for scratches and clearances. Check clearances of jack head to trailing edge over hydraulic cylinder as to clearance of turnbuckles.

Safety wire all turnbuckles with .041 stainless steel safety wire. Tighten and check nuts on cable fittings and jack shaft head. Tighten and check all fairlead bolts.

Operating tensions of cables are approximately 150 to 200 lbs. This is the lowest tension that can be held and keep the flaps in proper position on the flap-tracks.

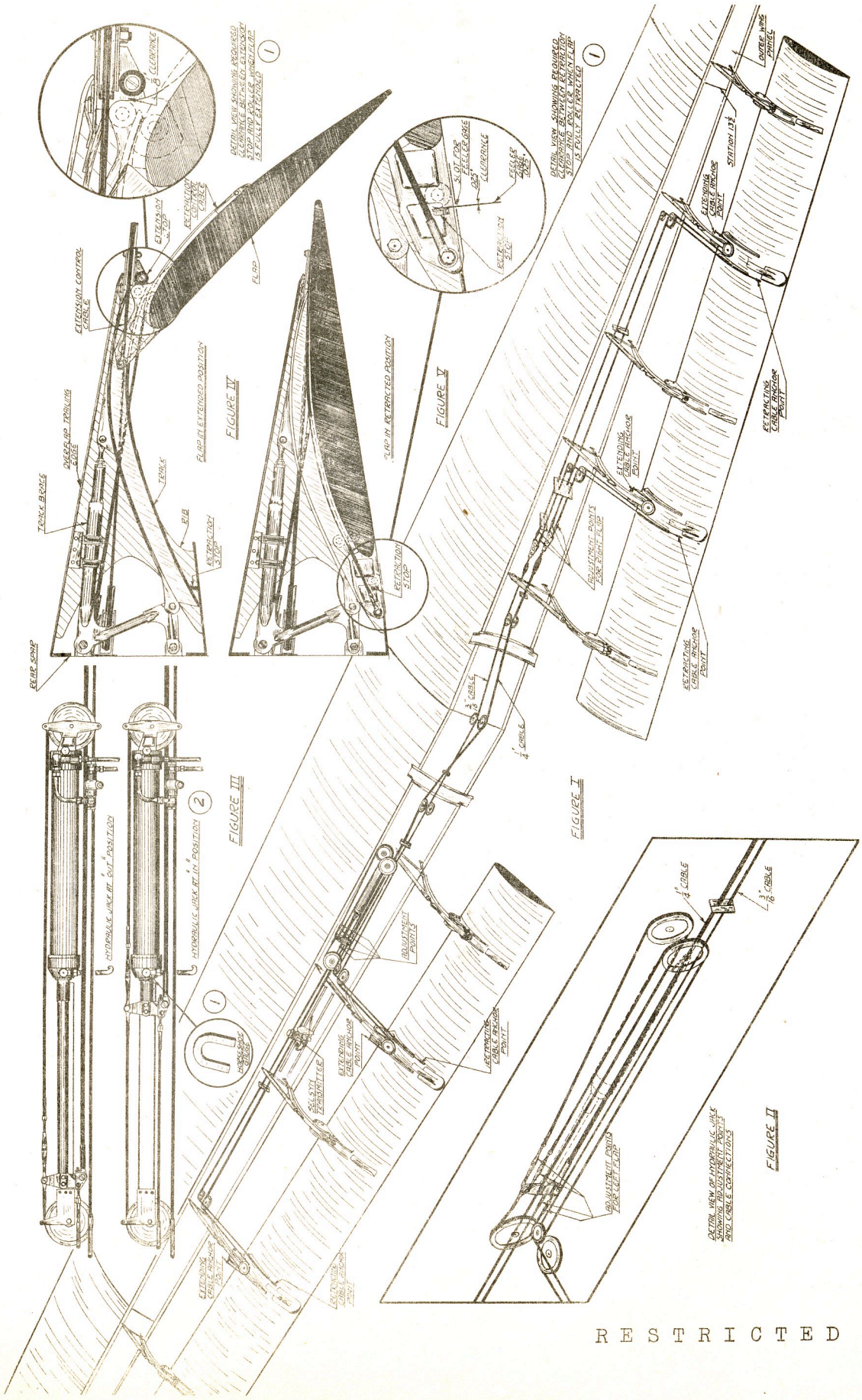
FIGURE I
FIGURE II
FIGURE III
FIGURE IV
FIGURE V
DETAIL VIEW OF HYDRAULIC JACKS SHOWING ADJUSTMENT POINTS AND CABLE CONNECTIONS
ADJUSTMENT POINTS FOR LEFT FLAP
ADJUSTMENT POINTS FOR RIGHT FLAP
ADJUSTMENT POINTS
EXTENDING CABLE ANCHOR POINT
RETRACTING CABLE ANCHOR POINT
EXTENSION CONTROL CABLE
TRACK BRACE
DROP-UP TERMINS
TERMS
FLAP
RETRACTION STOP
REAR SPAR
FLAP IN EXTENDED POSITION
FLAP IN RETRACTED POSITION
HYDRAULIC JACK AT OUT POSITION
HYDRAULIC JACK AT IN POSITION
HYDRAULIC JACKS
EXTENSION CONTROL
RETRACTION CABLE
DETAIL VIEW SHOWING REQUIRED CLEARANCE BETWEEN RETRACTION STOP AND ROLLER WHEN FLAP IS FULLY EXTENDED
DETAIL VIEW SHOWING REQUIRED CLEARANCE BETWEEN RETRACTION STOP AND ROLLER WHEN FLAP IS FULLY RETRACTED
SLOT FOR FEELER GAGE
FEELER GAGE
CLEARANCE
STATION 13½
DOUBLE WING PANEL
EXTENDING CABLE ANCHOR POINT
RETRACTING CABLE ANCHOR POINT
3/8" CABLE
1/4" CABLE

Airplane & Engine Mech Course (Special B-24)
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WING FLAP ROLLER ADJUSTMENT

OBJECTIVE: To make serrated bushing adjustment so that flap will move freely but snugly on track.

TOOLS:
1 small offset screwdriver
2 9/16" combination wrenches
1 1/2" combination wrench
1 feeler guage

EXPLANATION:

Mock-up

The mock-up is used to teach the preliminary roller adjustments that are made before the flap is installed. By these adjustments a near correct roller position is obtained prior to the placing of the flap in its position. Both top and center rollers of the carriage are adjusted with an .008-.015 clearance between the roller and track. In neutral position the top bushings are so adjusted that the shallow-walled side points fore, whereas the bottom roller bushings have the shallow wall pointing aft.

Procedure

A. Insert a master track in the carriage and use a feeler guage to determine which rollers need adjustment. (.008-.015 clearance)

B. If either of the top rollers needs adjustment proceed as follows:
1. Remove cotter key, nut, and washer from one bolt and push bolt and roller assembly toward center.
2. Mark position of bushing on housing.
3. Cause bolt to bind bushing and push outward. (This will cause bushing to protrude sufficiently from housing so that it may be removed.)
4. Turn bushing until you believe proper adjustment is made. (one serration will make a difference of approximately .003-.004.)
5. Replace bushing, washer, and nut.
6. Test with feeler guage for proper clearance and if necessary continue to adjust.

C. Should the center rollers need adjustment the following procedure should be followed. Keep in mind that both bushings are to be adjusted as a unit or the bolt will bind.
1. Remove cotter key, nut, and washer.
2. Insert the same size bolt in the roller assembly and push the original bolt out, thus keeping roller assembly complete.
3. Mark position of the bushing nearest threaded end of bolt.
4. Remove and adjust bushing.
5. Replace original bolt and adjust other bushing. (Both bushings to be aligned same.)
6. Replace washer and nut.
7. Test with feeler guage for proper clearance and if necessary continue to adjust.

On Ship

The chief point to observe in adjusting flap rollers on ship is that the flap must move freely yet without excessive play. The rollers are tested and adjusted after the flap is properly rigged and in full down position. In most cases the bottom rollers will take care of any necessary adjustment after the flap is on the ship.

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1. What type of flap is used on the B-24? How does the movement of this type of flap differ from the movement of the three primary movable surfaces?

2. What type of system moves the flaps? Where is the actuating cylinder?

3. What two main disconnections must be made before we can remove a flap? What else should be removed to prevent unnecessary damage?

4. How can we check to see whether the flap tracks are properly aligned with each other before installing a new flap?

5. If one track is lower or higher than the rest, how can it be aligned with the rest? Must the flap be removed to make the adjustment?

6. How are the rollers of each carriage assembly adjusted so that the flap will roll freely, yet firmly, over the tracks? What tolerances should these adjustable rollers satisfy?

7. What keeps the flaps from swaying laterally? What adjustment could be made if there were too much side play?

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8. How can we set the flap in "down" position so that it will be approximately right when it is moved to "up" position?

9. When setting the clearance at the forward stops, why do we use a "horseshoe" gage on the piston?

10. What should be the clearance at the forward stops when the flap is in "up" position and properly rigged? How is this measured?

11. If the clearance at the forward stops is not correct, where do we make the adjustment? Should this adjustment be made when the flaps are in the "up" position?

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DE-ICER QUESTIONS

1. Name two lubricants used under de-icer shoes and explain why used.

_____

_____

2. With what should de-icer shoes be coated if the ohmmeter shows a resistance of over 15,000 Ohms? _____

3. What is meant by combing a de-icer shoe? _____

_____

4. What is the purpose of the snubber on a de-icer shoes, and why is tape used at its point of attachment? _____

_____

_____

5. Should a de-icer shoe be installed by working from inboard to outboard, or outboard to inboard? _____

6. How are de-icer shoes safetied at point of attachment to vacuum lines?

_____

7. What precautions should be observed in the preparation of de-icer shoes for storage? _____

_____

_____

8. What is the allowable amount of increased width due to stretch in a de-icer shoe? _____

9. What provision is made for outboard creep of the de-icer? _____

_____

10. Name several inspection items regarding de-icers. _____

_____

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RUDDER-REMOVAL AND INSTALLATION

Tools: 1/2" socket, ratchet, open-end wrench, 3/8" open end wrench, 7/16" open end wrench, 5" screwdriver, wire twister, safety wire, diagonal cutters, and cotter pins.

Removal:
1. Disconnect bonding wire.
2. Disconnect tab horn from tab push-pull tube.
3. Disconnect rudder horns from rudder push-pull link.
4. Remove bolts at four hinge points, detaching entire hinge from rudder spar.
5. Slide rudder aft until clear of brackets.

Installation:
1. Reverse steps of removal with following precaution: Before attaching rudder horns to rudder push-pull link, lock the rudder link in neutral position and line up the surface in neutral position to fin with a straight edge. If rudder horns and rudder link will not line up when they are both in neutral, make adjustment by screwing the rudder link T-head in or out until they do line up; after alignment tighten lock nut that locks the link T-head.
2. If tab is out of neutral when control at pedestal reads zero and rudder is locked, make adjustment as given under Installation of Tabs.
3. Safety all bolts with cotter pins or safety wire as required.

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RIGGING RUDDERS ON B-24-E

To Rig the Rudder Surfaces: Lock the push-pull tube in the stabilizer. This is the neutral position.

The rudder surfaces can be trimmed for neutral position by placing a straight-edge alongside the fin at the first row of rivets under the stabilizer at the same level on each side. See Figure II. Measure at the trailing edge of the rudder. The measurement should be within 3/32" from each side. See Figure II -(1).

Adjustment is made at the threaded end of rudder push-pull tube attached to the rudder horn. See Figure II - (2). After adjustment tighten lock-nut on push-pull tube. The same procedure is performed on both rudders, left and right.

To Rig the Rudder System: Lock the rudders in the neutral position, with the controls lock.

Tighten the two turnbuckles in the tunnel on left side between Station 3.0 and Station 4.1 so that the threads are even with the ends of the turnbuckle. See Figure I - (1).

Tighten the two turnbuckles in the bomb bay evenly until a tension of 60 lbs., (minus 0, plus 10 lbs.), at 70° F. is reached. See Figure I - (2).

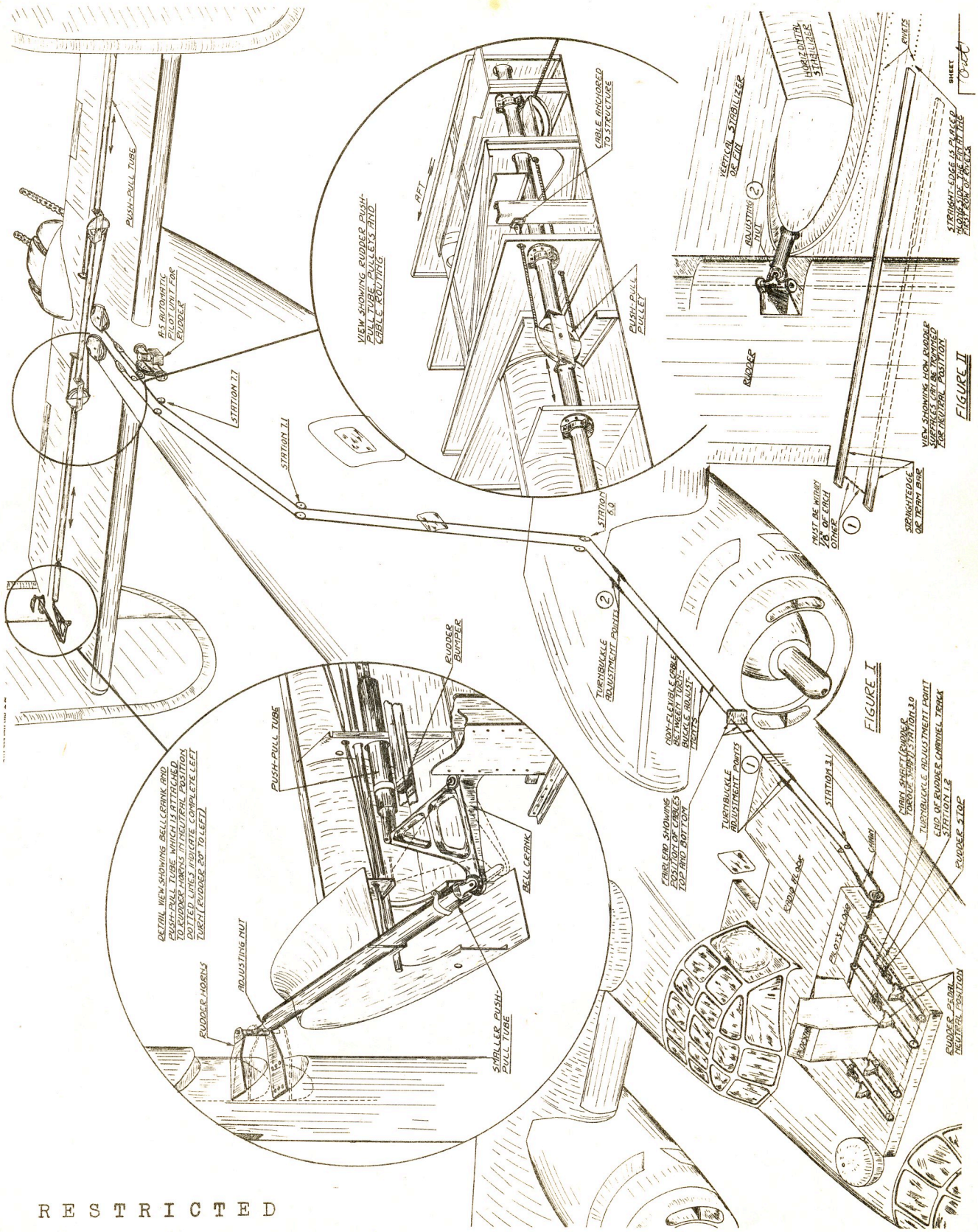
Rigging Rudder Pedals After Tension Has Been Applied to Main Cables: Adjust pedal carriages to neutral position which is reached when rear of carriage is 8 inches ahead of Station 1.2 by turnbuckles on pedal chains between idler pulleys and torque shaft. See Figure III - (1).

The rudder stops, Figure III - (2), are set at the factory to give 1/8 inch cushion of the rudder carriage at the stop. If the stabilizer has been changed in the field and the required cushion of 1/8 inch cannot be gained, the rudder pedal stop, (Figure III - (2), must be reworked to allow 1/8 inch cushion of the pedal, otherwise the rudder stops in the stabilizer would be ineffective, and full throw of the rudders could not be obtained. This done by pushing the rudders to full throw, then set the stop by measuring back 1/8 inch from the aft end of the carriage. Push the pedal down against the stop and set the other stop.

If the pedals are set ahead of 8 inches for neutral position, they will strike the angle on the forward end of the cover plate between the rudder tracks. If aft of 8 inches, the chain will run too close to the end of full throw.

Both extra flexible 3/16 (7 x 19) and non-flexible 3/16 (1 x 19) cable is used.

Color Code: Ship to right - green.
Ship to left - green and black.


PUSH-PULL TUBE
B-5 AUTOMATIC PILOT UNIT FOR RUDDER
STATION 7.7
STATION 7.1
STATION 6.0
VIEW SHOWING RUDDER PUSH-PULL TUBE, PULLEYS AND CABLE ROUTING
AFT
CABLE ANCHORED TO STRUCTURE
PUSH-PULL PULLEY
VERTICAL STABILIZER OR FIN
HORIZONTAL STABILIZER
ADJUSTING NUT
RIVETS
STRAIGHT-EDGE IS PLACED ALONG SIDE THE FIN WITH THE RIGHT ROW OF RIVETS
RUDDER
VIEW SHOWING HOW RUDDER SURFACES CAN BE TRIMMED FOR NEUTRAL POSITION
FIGURE II
MUST BE WITHIN 1/8 OF EACH OTHER
STRAIGHTEDGE OR TRAM BAR
TURNBUCKLE ADJUSTMENT POINTS
NON-FLEXIBLE CABLE BETWEEN TURNBUCKLE ADJUST POINTS
TURNBUCKLE ADJUSTMENT POINTS
FIRLEAD SHOWING POSITION OF CABLES TOP AND BOTTOM
STATION 3.1
CRANK SHAFT (RUDDER TORQUE TUBE) STATION 3.0
TURNBUCKLE ADJUSTMENT POINT
END OF RUDDER CHANNEL TRUNK STATION 1.2
RUDDER STOP
FIGURE I
RUDDER PEDAL NEUTRAL POSITION
DETAIL VIEW SHOWING BELLCRANK AND PUSH-PULL TUBE WHICH IS ATTACHED TO RUDDER HORNS IN NEUTRAL POSITION DOTTED LINES INDICATE COMPLETE LEFT TURN (RUDDER 20° TO LEFT)
RUDDER BUMPER
PUSH-PULL TUBE
BELLCRANK
ADJUSTING NUT
RUDDER HORNS
SMALLER PUSH-PULL TUBE

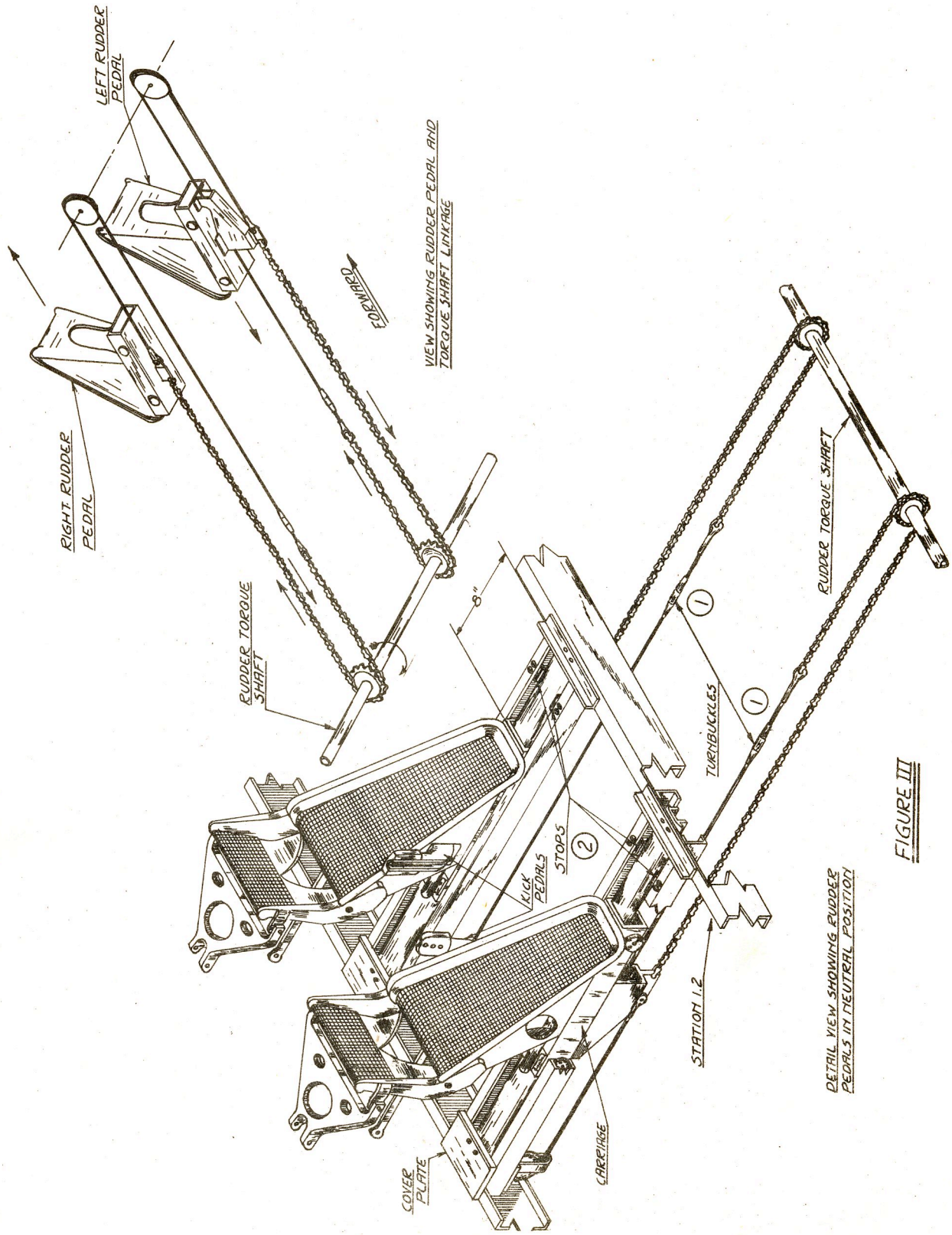

LEFT RUDDER PEDAL
RIGHT RUDDER PEDAL
VIEW SHOWING RUDDER PEDAL AND TORQUE SHAFT LINKAGE
FORWARD
RUDDER TORQUE SHAFT
8"
RUDDER TORQUE SHAFT
TURNBUCKLES
1
1
KICK PEDALS
STOPS
2
STATION 1.2
CARRIAGE
COVER PLATE
DETAIL VIEW SHOWING RUDDER PEDALS IN NEUTRAL POSITION

FIGURE III

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RUDDER QUESTIONS

1. In order to interchange the rudders, what minor adjustments must be made?

2. Besides trimming the plane in level flight, how does the tab on the rudder help the pilot turn in the rudder surfaces?

3. What other aid, built into the structure of the rudder aids the pilot in turning the rudder surfaces?

4. List, briefly, the main steps in removing a rudder.

5. When detaching the rudder from the stationary brackets, are the hinges left with the rudder or the vertical stabilizer?

6. When installing a rudder, in what position do we put the rudder to adjust it to line up with the corresponding positions of the rudder pedals? How do we make adjustments?

7. Why is it necessary to lock the rudder when aligning the rudder tab correctly?

8. If the tab is not in its correct neutral position, when the main surface is locked and the knob at the pedestal reads zero, where is the adjustment made?

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RUDDER QUESTIONS CONT.

9. How are the rudder pedals rigged so that one moves forward when the other moves backward?

_____

_____

10. What is the position of each rudder pedal assembly when the rudder system is properly locked in neutral? Is this the position of the pedal or the carriage?

_____

_____

11. How are the rudder pedals adjusted for pilot's leg length?

_____

12. How can we adjust a pedal assembly if it is not properly aligned to neutral, or if the cushion is not the same for full left and right throw?

_____

_____

13. Briefly, trace the rudder cables from torque shaft to push-pull rod. Where are the bellcranks and what do they do?

_____

_____

_____

_____

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ELEVATOR - REMOVAL AND INSTALLATION

Tools: Midget ratchet, 7/16" socket, 7/16" deep socket, 7/16" combination wrench, 3/8" combination wrench, 1/2" combination wrench, 5" screwdriver, wire twister, safety wire, diagonal cutters, cotter pins.

Removal:

1. Remove fairing and access plates on horizontal stabilizer, in island structure and at outboard end.
2. Detach removable pieces over elevator torque tube in island structure ribs.
3. Disconnect bonding wire, at points affected by elevator removal.
4. Disconnect tab horn from tab push-pull rod and remove push-pull rod by screwing it out of rod-end (bearing head) near elevator hinge line.
5. Remove bolt which connects elevator push-pull rod to elevator horn.
6. Remove bolts attaching torque tube to elevator stop-arm at centerline of stabilizer.
7. Remove bolts at hinge points, detaching entire hinges from elevator spar. (Avoid skin damage at outboard end by maneuvering elevator, up or down, to allow proper application of socket and ratchet.)
8. Lift elevator until free.

Installation:

1. Reverse steps of removal with following precautions: Check alignment bolt and be sure holes of elevator stop-arm at centerline are properly aligned with the holes in the torque tube flange so that the elevator surface will be in neutral when the controls lock is locked. Also, be sure no bolts are exposed across elevator stop-arm so that they will prevent full elevator throw.
2. If tab is out of neutral when control at pedestal reads zero and elevator is locked, align to neutral by adjusting rod-end (bearing head) on aft end of elevator tab push-pull rod.
3. Safety all bolts with cotter pins or safety wire, as required.

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RIGGING ELEVATORS ON THE B-24E

To Rig the Elevator System: See that all installations are made and cables properly strung and the system in order.

Engage the control lock with the elevators in a neutral position. Adjust the elevator push-pull tubes at station 9 so that the center of the lower pulley of the bell crank is 10-3/8 inches from the forward face of station 9, left and right sides. Tighten locknuts on push pull tubes, Figure II- (2). Adjust turnbuckles in the tunnel between Station 3.0 and Station 4.0 so that threads are flush with the ends of the turnbuckles. See Figure I - (1).

Lock elevator with the controls lock at the tail and set the chain on the torque shaft on the left hand side. Figure I - (2), and draw the cables up to a low tension of 30 or 35 lbs. Then put the right hand chain on the sprocket and jump it until cables in the bomb bay will come together. Bring its tension up to the cables on the left hand side and then set the control columns.

To set the control columns, pull them out until they both read 7-3/16 inches or as near as possible. This measurement is taken from the cover plate at the aft end of the control columns to the aft end of the sliding tube. Figure IV - (1). When the control columns are pulled out to this measurement, put the run around chain on the torque shaft sprocket and apply tension to it, see Figure IV - (2). After this is completed, set the cushion.

To do this push the column all the way in and see if it springs back when it is turned loose. Pull it all the way out and observe the same thing.

This cushion comes from the stops hitting in the tail, Figure III - (1), before the stops hit in the control columns. See Figure IV - (3).

When the stop hits in the tail and the column is forced down against its stop, it causes a slight stretching of the system, and it causes the column to spring back as soon as it is released.

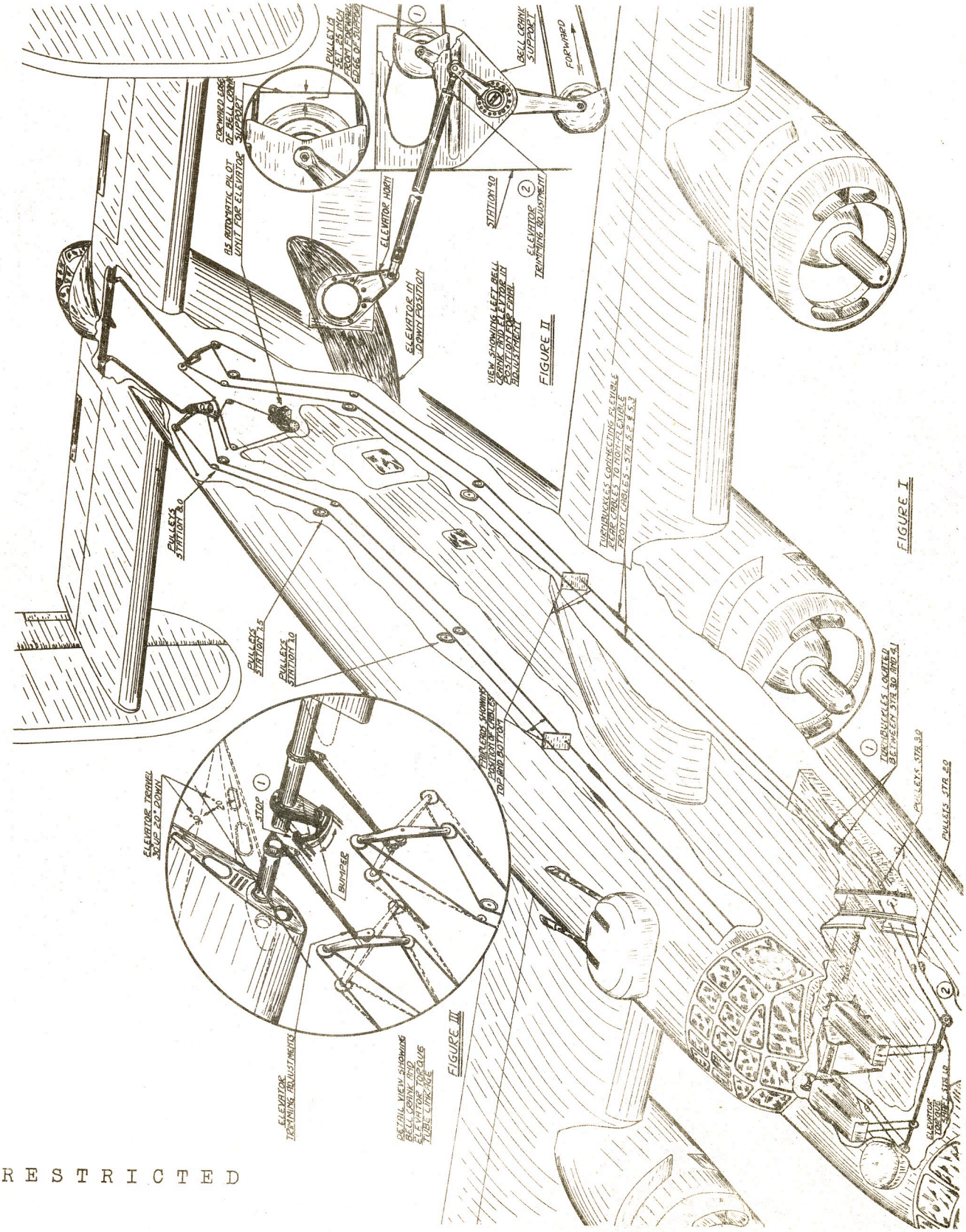
There will probably be more cushion one way than the other. This can be served by adjustment of the turnbuckles in the bomb bay or the turnbuckles in the run around chain.

If there is more cushion in a down position that in an up position, loosen the top cables in the bomb bay on both sides the same amount and tighten the bottom cables the same amount as you loosened the top cables. If there is more cushion in an up position, reverse the operation. After the cushion is adjusted, bring up the tension to 75 lbs. (plus or minus 5 lbs.), being careful not to spoil the tension. Tighten the same amount on each cable. Then test cushion again, and if necessary, reset it. After the cushion and tension is completed to your satisfaction, safety wire it at once.

Then check all clearances and make sure bonding is installed.

Both extra flexible 3/16 (7 x 19) and non-flexible 3/16 (1 x 19) cable is used.

Color Code: Ship up - Yellow
Ship down - Yellow and Black.


PULLEY 17 SEE FIG. 1 FROM FORWARD EDGE OF SUPPORT
FORWARD LOC OF BELL CRANK SUPPORT
BELL CRANK SUPPORT
FORWARD
AS AUTOMATIC PILOT UNIT FOR ELEVATOR
ELEVATOR HOMT
STATION 90
ELEVATOR TRIMMING ADJUSTMENT
ELEVATOR 101 DOWN POSITION
VIEW SHOWING LEFT BELL CRANK AND ELEVATOR POSITION FOR FORWARD ADJUSTMENT
FIGURE II
TURNBUCKLES CONNECTING FLEXIBLE REAR CABLES TO RIGID CONTROL FRONT CABLES - STA. 6.2 & 5.3
PULLEY STATION 3.0
PULLEYS STATION 2.5
PULLEYS STATION 2.0
FIGURE I
TURNBUCKLES LOCATED BETWEEN STA 30 AND 41
PULLEYS STA. 30
PULLEYS STA. 20
ELEVATOR TRAVEL 30 UP 20° DOWN
STOP
BUMPER
FOUR RODS SHOWING POSITION OF CABLES TOP AND BOTTOM
ELEVATOR TRIMMING ADJUSTMENTS
DETAIL VIEW SHOWING BELL CRANK AND ELEVATOR TORQUE TUBE LINKAGE
FIGURE III

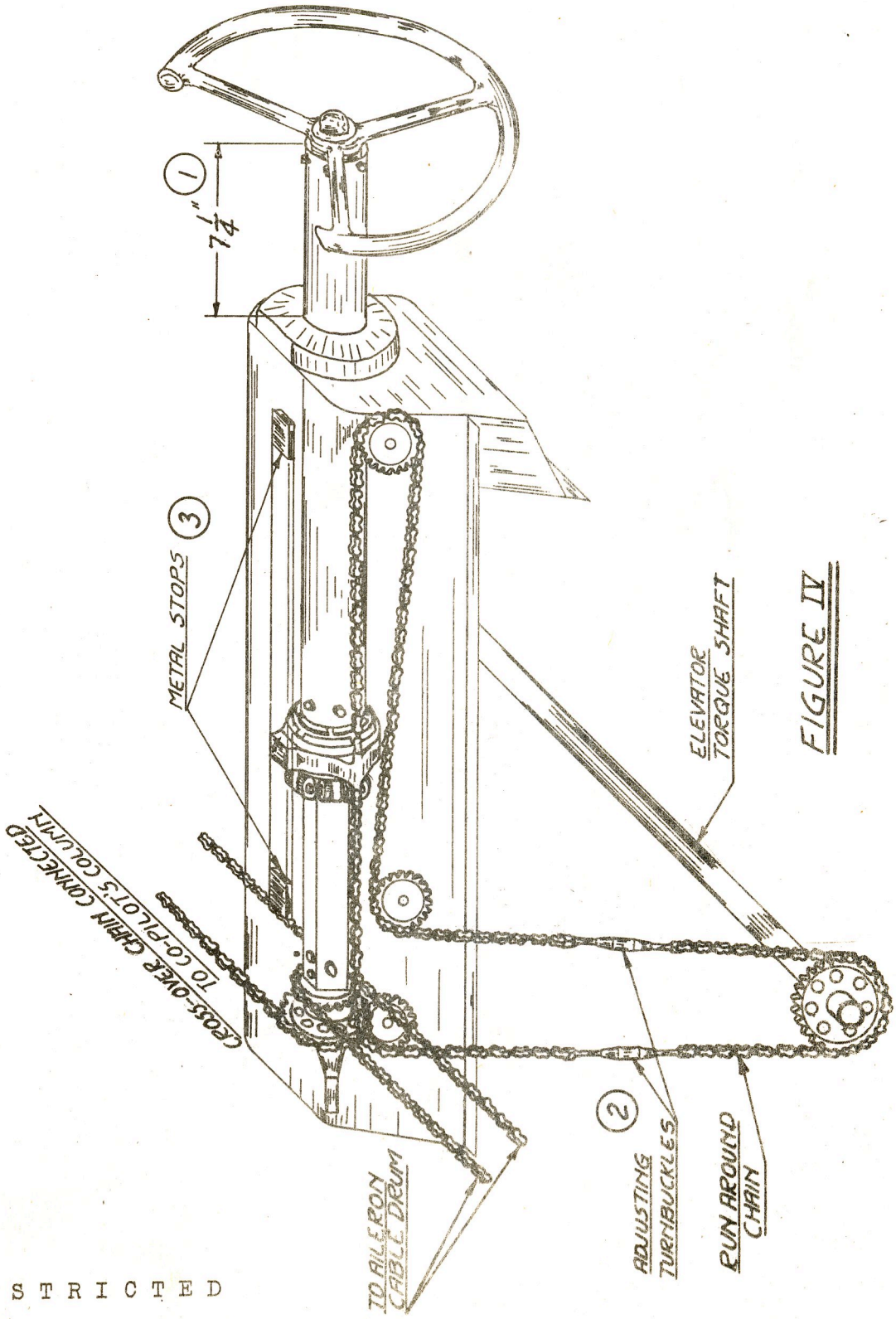

1
7 1/4"
3
METAL STOPS
CROSS-OVER CHAIN CONNECTED TO CO-PILOT'S COLUMN
TO AILERON CABLE DRUM
2
ADJUSTING TURNBUCKLES
RUN AROUND CHAIN
ELEVATOR TORQUE SHAFT

FIGURE IV

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ELEVATOR QUESTIONS

1. How are the right and left parts of the elevator linked together?

2. What two features of the elevator aid the pilot in moving this surface?

3. Why can't the elevators be interchanged?

4. Is it necessary to disconnect any cables or turnbuckles when removing an elevator?

5. Why must the elevator tab push-pull rod be removed before removing an elevator?

6. In regards to removing the hinges, is the same procedure followed as in the case of the rudder? (Are they left with the fixed or movable surface?)

7. When aligning an elevator to its proper neutral position, is it necessary to use a tramming bar (or straight edge)? Why?

8. What causes elevator control columns to move together?

9. What is the position of the elevator control columns when the elevator system is properly locked in neutral?

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ELEVATOR QUESTIONS CONT'D

10. How can we adjust an elevator control column if it is not properly aligned to neutral, or if the cushion is not the same for full up and down throw?

11. What clearance is obtained by using the adjustable forward end of the elevator push-pull rods?

12. Briefly, trace the elevator cables from torque shaft to bellcrank. Where are the bellcranks and what do they do?

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PARTS CATALOGUE QUESTIONS

1. How can Ford made parts ~~be identified~~? _____

2. How can you tell from a part number the approximate use that part may have on the ship? _____

_____

3. What is the T.O. number of the Ford Parts Catalogue? _____

4. In addition to the parts catalogue, where can a list of part numbers be obtained? _____

ADDITIONAL QUESTIONS ON CONTROLS

CABLE IDENTIFICATION:

1. For what system is the pair of 3/32 cables on the left side of the fuselage?

2. For what system is the single 3/32 cable on the left side of the fuselage? Why is there only one cable instead of a pair?

3. What five pairs of cables enter the horizontal stabilizer?

4. All cables cross which run along the rear spar of the right wing. What three sets of cables are herein referred to?

5. When the color black is used to code the control cables, it can have any one of three meanings. What are these three possible meanings and what determines which meaning applies in a particular case?

TABS:

6. What two disconnections are made in order to remove a tab?

7. Why don't we take the hinge pin out of the tab hinge in order to remove the tab?

TABS (Cont):

8. What is the purpose of the door cut into the fabric of a movable surface opposite each push-pull rod?

9. What causes the tabs to servo and what is the amount of the tab servo on the rudder, elevator, and aileron?

CONTROL LOCK:

10. What holds the control lock handle locked against the spring loaded locking system?

11. If control lock handle is pulled far enough to engage all three surface locks, but strap from ceiling will not reach it, can we pull handle up to meet strap? Why?

12. In what compartment in the fuselage does the single set of cables from the handle for the control lock branch into two sets? Where does each of these two sets go?

13. At all three drums in the control lock system (one at handle and one at each lock) the locking cable enters at the same place. Does it enter the forward or aft side? On the right or left?

14. What is the position of the staking bolt on each control lock drum when the system is in unlocked position?

ADDITIONAL QUESTIONS

15. When adjusting a turnbuckle, we are either adjusting for tension or setting a system. What is important in the former and what is important in the latter?

_____

_____

_____

_____

16. What are two inspection items for turnbuckles?

_____

_____

17. Name three other important general inspection items.

_____

_____

_____

18. Give the minimum clearances allowed between the following associate parts:

Unsupported cables and tubing _____
Cables and metal _____
Cables and pulley guards _____
Cables and fairleads _____

19. Is it necessary to add lubrication to the control columns or flap tracks?

_____

20. The primary surface and tab knobs, handles, or pedals are rigged so that the pilot can fly by "feel". In other words, the knob, handle, or pedal turns about the same axis as the corresponding movement of the airplane. Why is this important for the mechanic to know?

_____

_____

_____

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ADDITIONAL QUESTIONS

21. Why is the A-5 Emergency Release used only when the electrical release fails?

22. Where are the gyro units for the A-5 system located? Where are the amplifier units for the A-5 system located?

23. When replacing a cable, is it necessary to temporarily remove the pulleys through which that cable runs? Why?

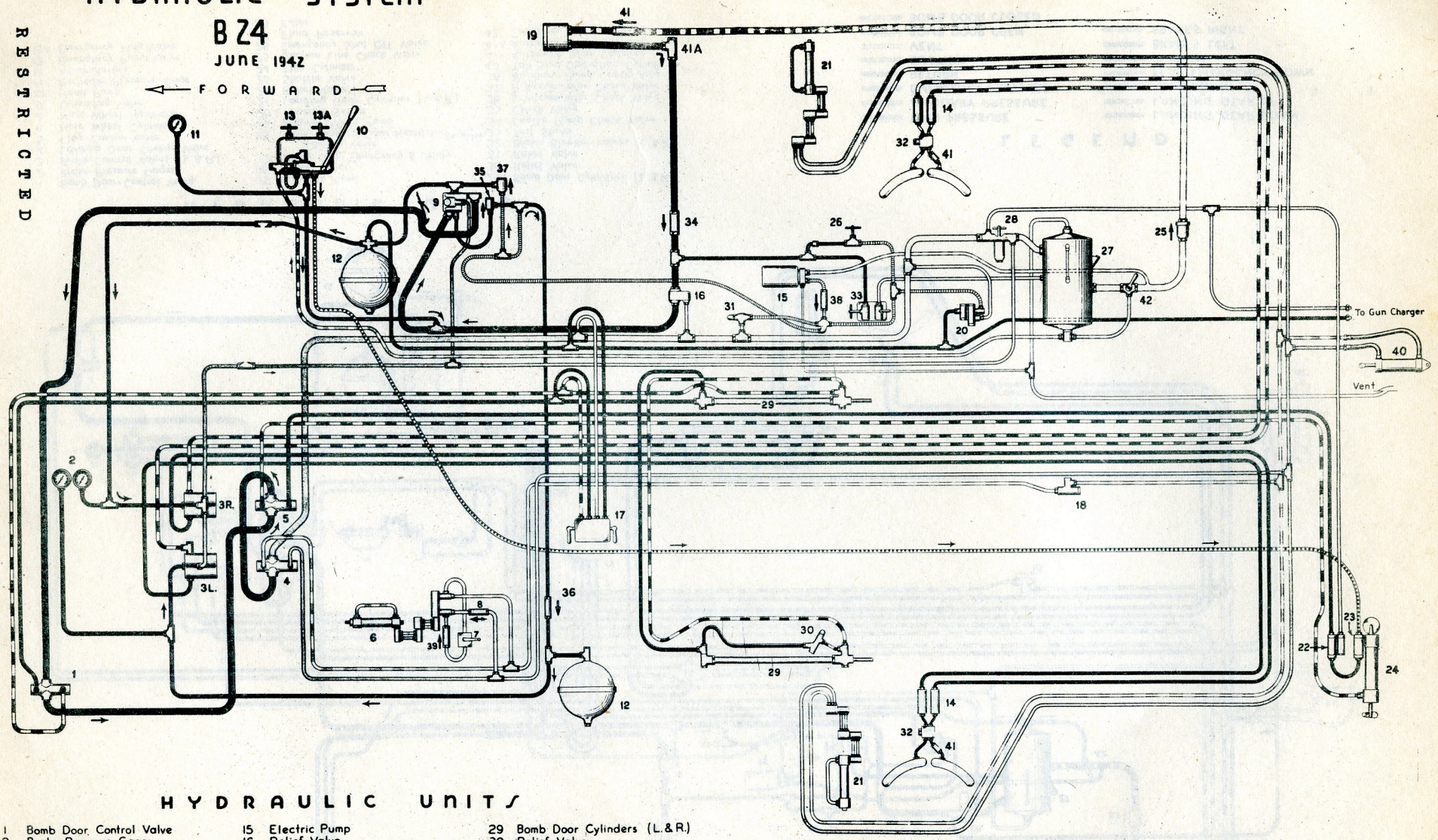
24. On what type of cable will a tensiometer fail to work? When can't we use this type of cable?

Fill in the necessary information on the following chart:

	RUDDER	ELEVATOR	AILERON	TABS
SIDE OF FUSELAGE WHICH CABLES ARE LOCATED ON				
COLOR CODE				
SIZE & TYPE OF CABLE				
LOCATION OF NON-FLEX CABLE				
TENSION OF CABLES				
THROW OF SURFACE				
LOCATION OF (FIRST) STOPS				
LOCATION OF SECONDARY STOPS				
WHAT IS SEQUENCE OF LOCKING AND WHAT DOES LOCKING FIN ENTER TO LOCK SYSTEM?				
LOCATION OF A-5 SERVO UNIT				(ELEVATOR) TAB
WHERE DOES A-5 SERVO UNIT TIE INTO CONTROL SYSTEM?				(ELEVATOR) TAB

HYDRAULIC SYSTEM
B 24
JUNE 1942

RESTRICTED



HYDRAULIC UNITS

1 Bomb Door Control Valve
2 Brake Pressure Gages
3 Brake Control Valves (L.& R.)
4 Landing Gear Control Valve
5 Flap Control Valve
6 Nose Wheel Cylinder
7 Nose Wheel Dump Valve
8 Nose Wheel Restrictor
9 Unloading Valve
10 Hand Pump
11 Hydraulic Pressure Gage
12 Accumulators (L.& R.)
13 Emergency Pump Valve
13A Emergency Flap Valve
14 Brake Deboosters (L.& R.)
15 Electric Pump
16 Relief Valve
17 Bomb Door Emergency & Utility Control Valve
18 Main Landing Gear Restrictor
19 Engine Driven Pump
20 Pressure Switch
21 Landing Gear Cylinder (L.& R.)
22 Relief Valve
23 Shuttle Valve
24 Flap Cylinder
25 Suction Line Check Valve
26 Emergency Shut Off Valve
27 Fluid Reservoir
28 Filter
29 Bomb Door Cylinders (L.& R.)
30 Relief Valve
31 Relief Valve
32 Brake Bleeder Valves (L.& R.)
33 Test Stand
34 Engine Pump Check Valve
35 Check Valve
36 L. Accumulator Check Valve
37 R. Accumulator Check Valve
38 Auxiliary Pump Check Valve
39 Nose Wheel Cylinder Check Valve
40 Tail Skid Operating Cylinder
41 Automatic Seal Coupling
41A Automatic Seal Coupling
42 Suction Valve

LEGEND

MAIN PRESSURE
AUXILIARY PRESSURE
EMERGENCY PRESSURE
RETURN
SUCTION
VENT
BOMB DOOR OPEN
BOMB DOOR CLOSED
LANDING GEAR DOWN
LANDING GEAR UP
FLAP DOWN
FLAP EMERGENCY DOWN
FLAP UP
BRAKES LEFT
BRAKES RIGHT

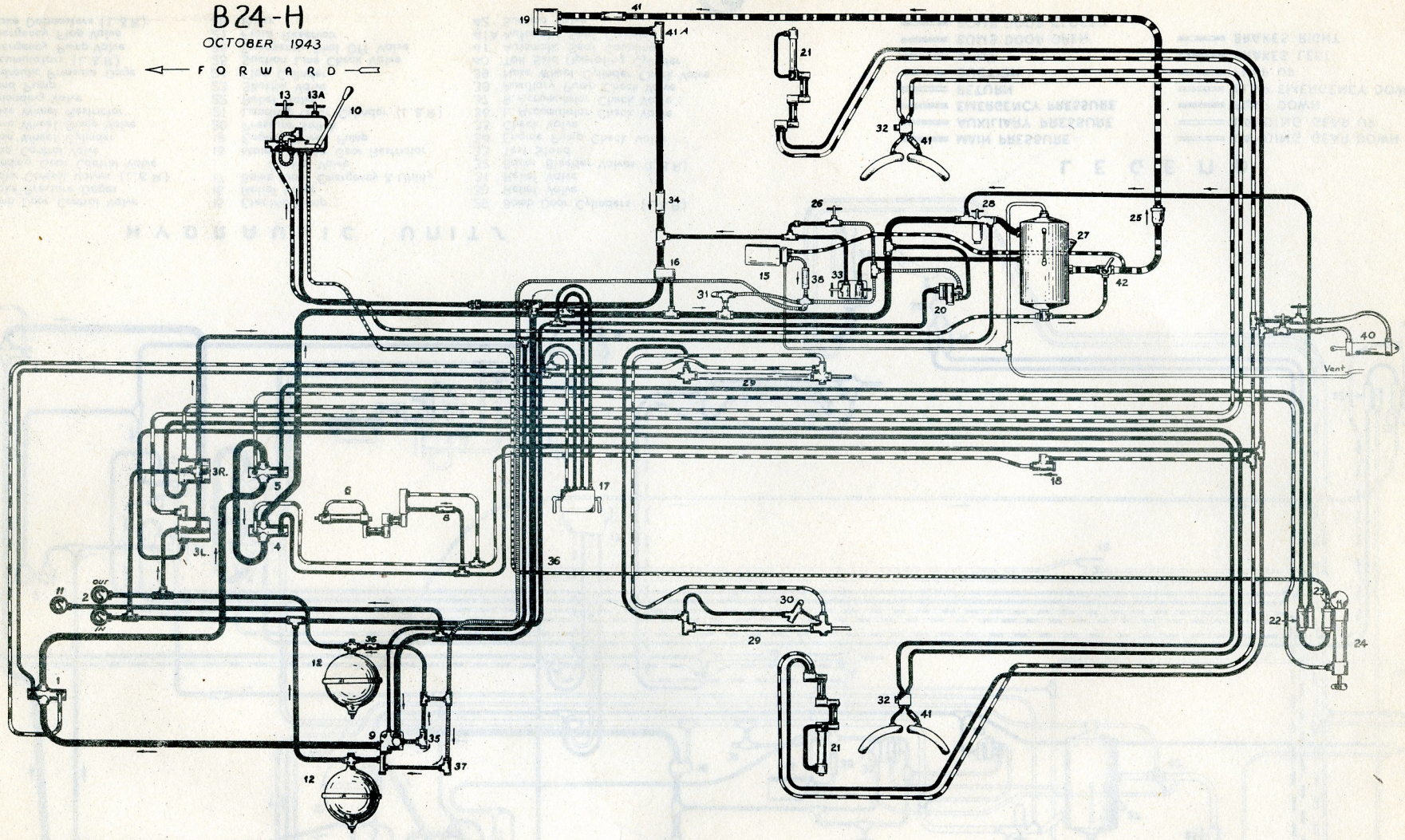
RESTRICTED

HYDRAULIC SYSTEM

B24-H

OCTOBER 1943

← FORWARD →



HYDRAULIC UNITS

1 Bomb Door Control Valve
2 Brake Pressure Gages
3 Brake Control Valves (L. & R.)
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6 Nose Wheel Cylinder
8 Nose Wheel Restrictor
9 Unloading Valve
10 Hand Pump
11 Hydraulic Pressure Gage
12 Accumulators
13 Emergency Pump Valve
13A Emergency Flap Valve
15 Electric Pump
16 Relief Valve
17 Bomb Door Emergency & Utility Control Valve
18 Main Landing Gear Restrictor (Sequence Valve)
19 Engine Driven Pump
20 Pressure Switch
21 Landing Gear Cylinder (L. & R.)
22 Relief Valve
23 Shuttle Valve
24 Flap Cylinder
25 Suction Line Check Valve
26 Emergency Shut Off Valve
27 Fluid Reservoir
28 Filter
29 Bomb Door Cylinders (L. & R.)
30 Relief Valve
31 Relief Valve
32 Brake Bleeder Valves (L. & R.)
33 Test Stand
34 Engine Pump Check Valve
35 Check Valve
36 L. Accumulator Check Valve
37 R. Accumulator Check Valve
38 Auxiliary Pump Check Valve
40 Tail Skid Operating Cylinder
41 Automatic Seal Coupling
41A Automatic Seal Coupling
42 Emergency Reservoir Valve

LEGEND

MAIN PRESSURE
AUXILIARY PRESSURE
EMERGENCY PRESSURE
RETURN
SUCTION
VENT
BOMB DOOR OPEN
BOMB DOOR CLOSED
LANDING GEAR DOWN
LANDING GEAR UP
FLAP DOWN
FLAP EMERGENCY DOWN
FLAP UP
BRAKES LEFT
BRAKES RIGHT

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HYDRAULIC SYSTEM LOCATIONS

Aim:

To learn the location of units and familiarize yourself with the lay-out of the hydraulic system and other related systems in the ship.

Equipment:

Mock-up ship, schematic diagrams, and fuselage stations diagram.

Procedure:

By use of schematics and fuselage stations diagram locate the various units indicated. Write your answers in the space provided. Location should be made by compartments in the ship as well as by Stations. In all cases be able to trace the hydraulic lines as they go from one unit to another. Put down location immediately after name of unit.

HYDRAULIC SYSTEM:

Open Center System:

1. Reservoir:
   a. Where does vent line end?
   b. What is specification of fluid used?

2. Emergency Reservoir Valve (Suction line valve).
   a. Normally, valve handle should be in what position?

3. Suction Line check Valve.
   a. What is main purpose of this valve?

4. Automatic Seal Couplings.
   a. On what occasion would these valves come into use?

5. Engine Driven Pump.
   a. What type pump is it?
   b. How is it primed?

6. Engine Pump Check Valve.

7. Main System Relief Valve.
   a. What is the setting of this valve?
   b. Where does by-passed fluid go?

8. Unloading Valve.
   a. What purpose does the valve serve?
   b. At what pressure should it kick in? Kick out?

9. Bomb Door Control Valve.

10. Flap Control Valve.

11. Landing Gear Control Valve.

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SYSTEM LOCATIONS (Cont'd)

12. Cuno Filter
    a. Where does fluid go from filter?
    b. How is filter cleaned?

Auxiliary Pressure System:

1. Auxiliary Electric Pump.
    a. What type pump is it?
    b. From where does it draw fluid?

2. Auxiliary Pump Check Valve.

3. Auxiliary Pressure Relief Valve.
    a. What is setting of this valve?
    b. Where does the by-passed fluid go?

4. Emergency Hydraulic Valve (Cross-over Valve).
    a. Under what conditions should this valve be opened.
    b. When in "closed" position must valve be safetied?

5. Electric Pressure Switch.
    a. Is this switch automatic with Cross-over valve open?
    b. What are the pressure settings on this switch?

6. Right Hand Accumulator Check Valve (37).

7. Left Hand Accumulator Check Valve (35).

8. Left Accumulator Surge Valve (36).

9. Test Stand (Test Connections).
    a. When are these connections used?
    b. Where does the suction line come from?

Bomb Door System:

1. Bomb Door Control Valve.
    a. What are the pressure kick-out settings on this valve?
        Open_____ Closed_____
    b. How can these settings be changed?

2. Bomb Door Cylinders (L & R)
    a. With doors open are pistons extended or all the way in?
    b. Will an excess of pressure in one cylinder register in the other cylinder as well?

3. Bomb Door Relief Valve.
    a. Is valve on "up" or "down" line?
    b. Does valve serve to relieve excess pressure in both cylinders?
    c. What is setting of valve?

4. Bomb Door Emergency and Utility Valve.
    a. When is this valve used?
    b. What pressure is used for this Emergency and Utility System?
    c. Where is the cam which must be reset when Emergency Valve

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SYSTEM LOCATIONS (Cont'd)

has been used?

5. Right Hand Accumulator.

Flap System:

1. Flap Control Valve.
   a. What are the pressure kick-out settings on this valve?
      Up_____ Down_____
   b. Where is the handle for the control valve located?

2. Flap Relief Valve.
   a. At what pressure does this valve relieve?
   b. Where does the by-passed fluid go?
   c. Under what circumstances is this valve supposed to operate?

3. Shuttle Valve.
   a. What is the purpose of this valve?
   b. How is the piston in this valve moved over in an emergency operation of the flaps?

4. Flap Actuating Cylinder.
   a. How are flaps on right wing operated?
   b. Can flaps be lowered manually, i.e. by mechanical means?

5. Hand Pump.
   a. Along what parts of the ship does the line from the hand pump to the shuttle valve go?
   b. What units in hydraulic system can be operated by the Hand Pump?

6. Emergency Pump Valve (Forward Valve).
   a. In normal operation of hydraulic system what is position of this valve?
   b. When valve is open where does fluid from hand pump go?

7. Emergency Flap Valve (Aft Valve).
   a. In Emergency operation of flaps what is position of this valve?
   b. In what position must both valves next to hand pump be in in order to permit the return of the shuttle valve?

Landing Gear System:

1. Landing Gear Control Valve.
   a. What are the pressure kick-out settings on this valve?
      UP _____ Down_____
   b. Where is the handle for the control valve located?

2. Nose Wheel Restrictor.
   a. Is this restrictor on the "up" or "down" line?
   b. What purpose does it serve?

3. Nose Wheel Cylinder.
   a. Is piston extended or retracted when the nose wheel is down?

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SYSTEM LOCATIONS (Cont'd.)

b, What allows the cylinder freedom of movement?

4. Landing Gear Cylinders (L & R)
   a. Are these cylinders with the attached swivel joint interchangeable?
   b. Are the pistons extended or retracted when the main gears are down?

5. Main Landing Gear Restrictor (or Sequence Valve).
   a. Is this valve on the "up" or "down" line?
   b. What is the purpose of this valve?

Brake System:

1. Brake Control Valves.
   a. The pressure used comes from where?
   b. Where does the brake return fluid go?
   c. Where is the parking brake lever located?
   d. What brake does the right pedal operate?
   e. What brake does the left pedal operate?

2. Accumulators (R. & L.).
   a. For what operations can right accumulator pressure be used?
   b. For what operations can left accumulator pressure be used?
   c. How much air pressure is originally put into the accumulators?

3. Brake Pressure Gages.
   a. What pressure is registered on these gages?
   b. When the pressure on these gages suddenly drops to zero we have a fairly accurate check on what?

4. Brake Bleeder Valves.
   a. How can you tell when brakes must be bled?
   b. For bleeding brakes how is bleeder valve opened?

5. Auto Seal Coupling on Inboard Brakes Lines.
   a. On what occasions is this auto seal counling used?

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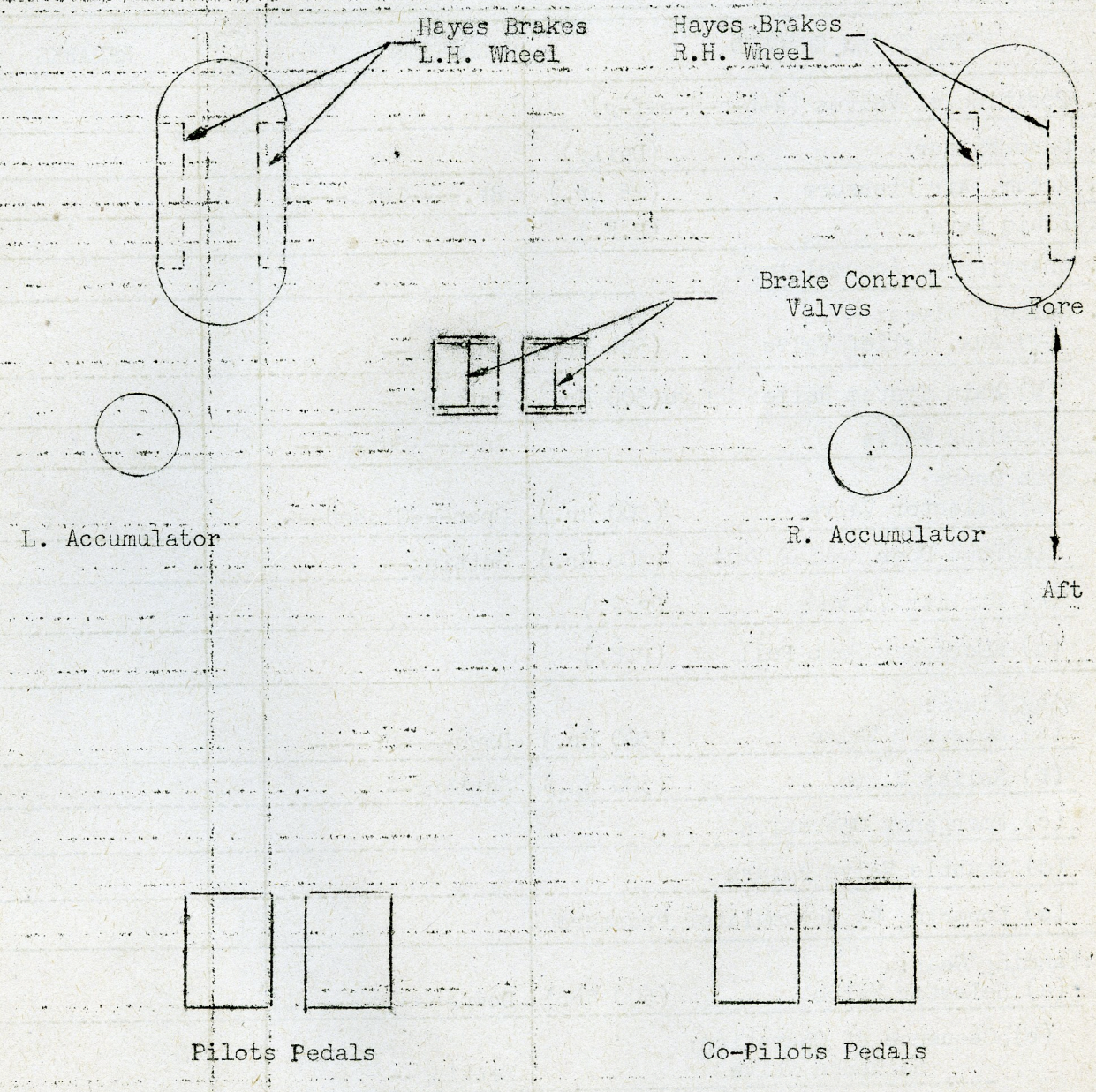
Make correct hydraulic line and mechanical linkage hookup on sketch below.



BRAKE SYSTEM DIAGRAM

Airplane & Engine Mech Course (Special B-24)
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INSPECTION OF B-24 HYDRAULIC SYSTEM

Introduction: This list of inspections is not complete. It is a selection of those items which entail a certain amount of care and precision in checking, as well as a few important routine inspections. (For procedure in checking, refer to Job Sheets II-4, -4a, -4b)

Class and Group_____ Crew Chief_____ Date _____ O.K._____

ITEMS TO BE CHECKED		CONDITION	SYMBOL	REMARKS
1. Position of Valves (a-b-c-d-e-f-g)				
2. Cuno Filter	(Daily)			
3. Accum. Air Pressure	(25 Hr.)	Rt.----Left-----		
4. Fluid Level	(P.F.)			
5. Charging of Accumulators				
6. Relief Valves:				
(a) Aux. Relief Valve	(500 Hr.)	Setting--		
(b) Main System Relief Valve	(500 Hr.)	Setting--		
7. Unloading Valve		In-----Out-----		
8. Bomb Doors:				
(a) Selector Valve	(500 Hr.)	Open---Closed---		
(b) Bomb Door Relief Valve	(500 Hr.)	Setting--		
(c) Utility Valve	(P.F.)			
(d) Emergency Bomb Pull	(P.F.)			
9. Wing Flaps:				
(a) Selector Valve	(500 Hr.)	Down----Up----		
(b) Relief Valve	(500 Hr.)	Setting--		
(c) Emergency Operation				
(d) Shuttle Valve Return				
(e) Lowering by Accumulator Pressure				
10. Landing Gear:				
(a) Selector Valve	(500 Hr.)	Down----Up----		
(b) Sequence of Operation:				
Sequence Valve		Setting--		
Nose Wheel Restrictor				
Tail Skid Operation				
11. Pressure Switch	(P.F.)	On-----Off-----		
12. Braking System:				
(a) Pressure Available (Accum.)	(P.F)	I.B.----O.B.----		
(b) Test Gage Pressures	(300 Hr.)	I.B.----O.B.----		
(c) Bleeding Brakes	(Special)			

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PROCEDURE FOR CHECKING B-24 HYDRAULIC SYSTEM:

Introduction:

The purpose of the steps outlined below is to assist in making a logical and systematic inspection of the entire system. Proper adjustments must be made if "kick-out" pressures on selector valves or relief valve settings are not right. Eliminate any trouble which may be encountered.

CAUTION: BE SURE TO DIAGNOSE AND LOCALIZE THE TROUBLE BEFORE STARTING WORK ON ANY UNIT

1. Normal Position of Valves. Put valves in positions indicated.
   (a) Emergency Reservoir Valve---must be in horizontal position except in emergency. If fluid level is low, turn valve to vertical position so as to draw from bottom of reservoir only.
   (b) Emergency Hydraulic Valve (or Crossover Valve)---always closed except if auxiliary pump must be used to operate Open Center.
   (c) Tail Skid Shut-off Valves should be open.
   (d) Bomb Door Emergency and Utility Valve must be closed---check sliding cam in nose-wheel compartment.
   (e) Selector Valves should all be in neutral.
   (f) Emergency Pump Valve (Forward valve next to hand pump) open.
   (g) Emergency Flap Valve (aft valve next to hand pump) closed.

2. Cuno Filter---give handle two complete turns. This must be done at least once a day.

3. Accumulator Air Pressure.
   (a) Discharge accumulators by operating brakes until brake pressure gages suddenly drop to zero.
   (b) Pressure at which gage suddenly drops to zero indicates amount of air pressure in accumulator.
   (c) Air pressure in right accumulator may be checked individually by use of Utility Valve.
   (d) 600 p.s.i. is the correct air charge for accumulators with all fluid out.

4. Fluid Level in Reservoir----directions are given on the reservoir itself as to amount required. Fluid used is AN-VV-O-366b.

5. Charging Accumulators through Open Center by use of piston pump.
   (a) On actual ship this would probably be done by auxiliary electric pump ---in this case Emergency Hydraulic Valve must be open.
   (b) If neither piston nor auxiliary electric pump are operative, use hand pump.
   (c) If an outside test stand is being used as the source of hydraulic pressure, attach same to test connections.
   (d) Fully charged accumulators should register approximately 1050 p.s.i.

6. If Accumulators can not be fully charged:
   (a) Check Open Center pressure gage to determine whether Unloading Valve has kicked out.
   (b) Set Flap Selector Valve in "down" position to determine if there is pressure in Open Center line beyond the unloading valve. This will detect a leaky unloading valve.
   (c) Check for possible loss of pressure through the Bomb Door Emergency Valve or through the Brake Control Valves.

(d) Check Auxiliary Pressure Relief Valve.
  (1) Make sure Emergency Hydraulic Valve is closed.
  (2) Start Auxiliary Electric Pump.
  (3) Auxiliary Electric Pump should charge accumulators to approx. 1160 p.s.i
  (4) High setting of relief valve (1300 p.s.i.) may be checked by forcibly holding the electric pressure switch in the "on" position.
(e) Check Main System Relief Valve.
  (1) If setting is below 1050 p.s.i., the unloading valve will not kick out.
  (2) High setting of 1250 p.s.i. may be checked by forcibly holding the landing gear selector valve in the "down" position. Use Auxiliary Pump and forcibly hold pressure switch in "on" position. An alternative method is setting up the "kick-out" pressure on a selector valve (Bomb Door "closed")---this is perhaps a more accurate check. A third, but less accurate method is that of overpowering the Bomb Door Selector Valve.

7. Unloading Valve Pressure Settings.
(a) Kick-in----850 p.s.i---while operating hand pump, slowly discharge the accumulators by use of the brakes.
NOTE: Stop pumping and discharging at once when the hand pump is loaded.
(b) Inboard brake pressure gage will show kick-in setting of unloading valve.
(c) Kick-out---1050 p.s.i.---when charging accumulators through Open Center, inboard brake pressure gage will show kick-out pressure.

8. Bomb Door System.
(a) Check kick-out pressures on Bomb Door Selector Valve by use of hand pump.
  Open: 600 ± 25 p.s.i.
  Closed: 1000 ± 25 p.s.i.
(b) Check setting of 750 p.s.i. on Bomb Door Relief Valve.
  (1) Completely discharge right accumulator with Utility Valve.
  (2) With landing gear down, put landing gear selector valve in "down" position.
  (3) Hold Utility Valve in "open" position and start Auxiliary Electric Pump.
  (4) Highest pressure attainable on inboard brake pressure gage is setting of Bomb Door Relief Valve.
(c) Check opening and closing of doors by use of Utility Valve.
(d) Check opening of doors by use of Emergency Bomb Pull on pedestal. Reset cam.

9. Flap System.
(a) Check kick-out pressures on Flap Selector Valve by use of hand pump.
  Down: 450 ± 25 p.s.i.
  Up: 750 ± 25 p.s.i.
(b) Check setting of 500 p.s.i. on Flap Relief Valve.
  (1) Landing gear must be in down position. Flaps may be in any position but all the way down.
  (2) Put both flap and landing gear selector valve in "down" position.
  (3) Operate hand pump.
  (4) Pressure shown on main system gage will be setting of relief valve.
  (5) If Auxiliary instead of hand pump is used, valve should be set to give a reading of approx. 575 p.s.i.
(c) Check Emergency Operation of Flaps.
  (1) Put flap selector valve in "down" position.
  (2) Close Emergency Pump Valve (forward valve).
  (3) Open Emergency Flap Valve (aft valve).
  (4) Operate hand pump to lower flaps.

(d) Check raising of flaps after emergency lowering.
  (1) Put flap selector valve in "down" position, leave aft valve next to pump open, and also open forward valve.
  (2) Operate hand pump until flap selector valve kicks back to neutral.
  (3) Close aft valve next to hand pump and put flap selector valve in "up" position.
  (4) Flaps can now be raised through Open Center line.

(e) Check emergency lowering of flaps by accumulator pressure.
  (1) Put flap selector valve in "down" position.
  (2) Place bomb door selector valve in "open" position.
  (3) With bomb doors in <u>closed</u> position hold Utility Valve in "closed" position.

10. Landing Gear System.
  (a) Check "kick-out" pressure of landing gear selector valve in "down" position. 850 ± 25 p.s.i.
  (b) While retracting landing gear (selector valve in "up" position) check the following:
    (1) Nose wheel should come up first due to main landing gear restrictor or sequence valve.
    (2) Nose wheel should come up slowly due to restrictor in nose wheel "down" line.
    (3) Pressure shown on main system gage while landing gear is being retracted will indicate setting of sequence valve. This valve will begin opening up at a pressure of 600 p.s.i.---it should be fully open at approx. 800 p.s.i.
    (4) Tail skid should retract with, or after, the main landing gear.
    (5) Kick-out pressure for selector valve in "up" position should be 1100 ± 50 p.s.i.

11. Check Operation of Hydraulic Pressure Switch.
  (a) Cross-over valve must be closed.
  (b) Start Auxiliary Pump and charge accumulators.
  (c) Electric Motor should kick out at approximately 1160 p.s.i.
  (d) Gradually discharge accumulators by use of brakes. The pressure at which the switch kicks "on" should differ from the "kick-off" pressure by no <u>more</u> than 230 p.s.i. nor less than 130 p.s.i.

12. Braking System.
  (a) Check pressure on inboard and outboard brake pressure gages. (Accumulator Pressure).
  (b) Operate brake valves and observe action of expander tubes as well as pressure on test gages (not on ship). Maximum pressure attainable should be no more than 250 p.s.i. nor less than 160 p.s.i.
  NOTE: BRAKE PRESSURES ARE EQUALIZED BY ADJUSTING LINKAGE ON PEDALS AND NOT BY ADJUSTING VALVES THEMSELVES.
  (c) Bleeding Brakes-----follow directions given on bleeder valve itself.

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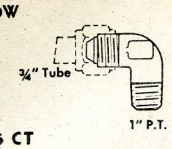
SURVEY SHEET FOR COLOR CODE IDENTIFICATION

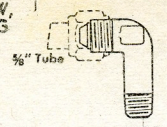
System	Color Marking
1. Air Pressure (Max. 20 p.s.i.)	1. _____
2. Anti-Icing Fluid (Alcohol)	2. _____
3. Anti-Icing Fluid (Alcohol & Glycerine)	3. _____
4. Heater Exhaust	4. _____
5. Fire Extinguishers	5. _____
6. Flotation Equipment	6. _____
7. Fuel--Gasoline	7. _____
8. Propane	8. _____
9. Heater Fuel-Air Supply	9. _____
10. Manifold Pressure	10. _____
11. Hydraulic Pressure Oil	11. _____
12. Oil	12. _____
13. Oxygen Distribution	13. _____
14. Oxygen Filler Line	14. _____
15. Pitot Pressure	15. _____
16. Static Pressure	16. _____
17. Vacuum	17. _____
18. Vent (Closed Compartments)	18. _____
19. Water	19. _____

CT
ELBOW



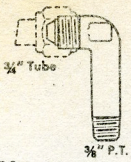
12-16 CT
- 2nd—PT Size
- 1st—Tube Size

CCT
ELBOW, LONG



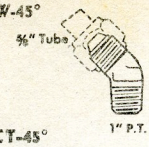
10-6 CCT
- 2nd—PT Size
- 1st—Tube Size

CCCT
ELBOW, EXTRA LONG



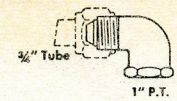
12-6 CCCT
- 2nd—PT Size
- 1st—Tube Size

CT-45°
ELBOW-45°



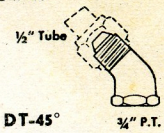
10-16 CT-45°
- 2nd—PT Size
- 1st—Tube Size

DT
ELBOW



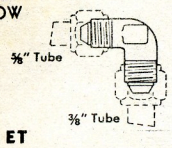
12-16 DT
- 2nd—PT Size
- 1st—Tube Size

DT-45°
ELBOW-45°



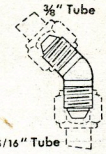
8-12 DT-45°
- 2nd—PT Size
- 1st—Tube Size

ET
ELBOW



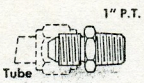
10-6 ET
- 2nd—Smaller Tube Size
- 1st—Larger Tube Size

ET-45°
ELBOW-45°



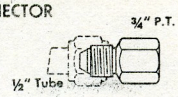
6-5 ET-45°
- 2nd—Smaller Tube Size
- 1st—Larger Tube Size

FT
NIPPLE



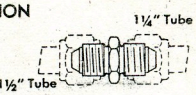
20-16 FT
- 2nd—PT Size
- 1st—Tube Size

GT
CONNECTOR



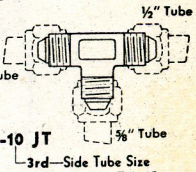
8-12 GT
- 2nd—PT Size
- 1st—Tube Size

HT
UNION



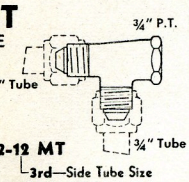
24-20 HT
- 2nd—Smaller Tube Size
- 1st—Larger Tube Size

JT
TEE



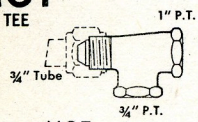
12-8-10 JT
- 3rd—Side Tube Size
- 2nd—Smaller Run Tube Size
- 1st—Larger Run Tube Size

MT
TEE



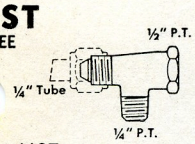
16-12-12 MT
- 3rd—Side Tube Size
- 2nd—Run PT Size
- 1st—Run Tube Size

MOT
TEE



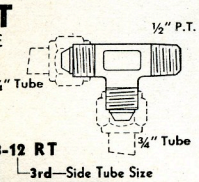
12-16-12 MOT
- 3rd—Side PT Size
- 2nd—Run PT Size
- 1st—Run Tube Size

MST
TEE



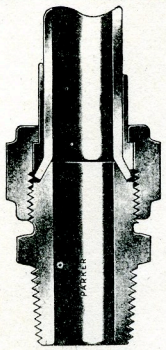
4-8-4 MST
- 3rd—Side PT Size
- 2nd—Run PT Size
- 1st—Run Tube Size

RT
TEE



12-8-12 RT
- 3rd—Side Tube Size
- 2nd—Run PT Size
- 1st—Run Tube Size

TRIPLE TYPE
AIR CORPS 811 STYLE



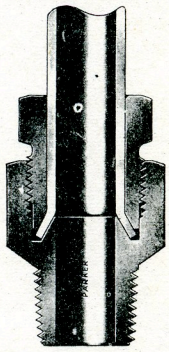
RESTRICTED

A combination or reducing fitting always makes a better installation than an assembly of several standard fittings, reducing bushings, etc. It weighs less, takes less space, is neater, and is stronger and tighter. Extensive patterns and dies have been accumulated for such fittings and limited stocks are carried in many items. Many other combinations or reducing fittings can be furnished when ordered in sufficient quantities. When small quantities are needed and are not in stock, standard fittings with adaptors or bushings should be accepted. Reducing nipples, connectors elbows, and tees in a reduction of one size can usually be furnished from stock at regular prices.

This chart illustrates all combinations of outlet types in which Parker tube couplings are available, with the detailed method of specifying reducing sizes. Complete specifications for any Parker Tube fitting must take into account the size, shape, type (Standard or Triple), weight, and material. To prevent errors in filling orders, specify fittings exactly as shown here.

NOTE: Symbols and specification examples shown with each reducing fitting illustrated are for triple type couplings, brass, standard weight, without tube nuts or sleeves.

STANDARD TYPE
AIR CORPS 810 STYLE



SIZE

Standard Sizes—When there are pipe threads on Parker Tube Couplings, the standard pipe thread size is as follows:

Fitting Size No.	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	24	28	32
Tube O.D.	⅛	3/16	¼	5/16	⅜	7/16	½	9/16	⅝	11/16	¾	⅞	1	1⅛	1¼	1½	1¾	2
Pipe Thread	⅛	⅛	⅛	⅛	¼	¼	⅜	⅜	½	¾	¾	¾	1	1	1¼	1½	1½	2

When all tube outlets on a fitting are of the same size, and all pipe threads (if any), are of the corresponding size listed in the above table, the fitting is considered to be "standard size" and is specified by using only the number indicating the sixteenths of an inch in the tube O.D. as the fitting size number. **Example:** An "FT" fitting with a 5/16" O.D. tube connection and ⅛" external pipe thread is a standard size nipple and is specified as a "No. 5 FT, Nipple."

Reducing Sizes—When the tube outlets are not of the same size, or when the size of any pipe thread outlet does not correspond to the tube size listed in the above table, the coupling is a "reducing" fitting and the size of each outlet must be given as shown on this chart. When specifying, place the tube and pipe thread outlets in the position illustrated for each shape and list the outlet sizes in the order designated. **Example:** An "ST" fitting with one ⅜" O.D. and one ¼" O.D. tube outlet and a ⅜" P.T. outlet is a "reducing" tee and is specified as "No. 6-4-6 ST, Tee." (Note that tube and pipe thread size numbers indicate sixteenths of an inch in the tube O.D. and nominal pipe thread size respectively.)

SHAPE AND TYPE

Triple Type—Triple type couplings are distinguished by the letter "T" in the shape symbol. Shape symbols shown with reducing fitting examples are for Triple Type Couplings, without nuts and sleeves. To specify with nuts and sleeves, insert the letter "B" before the letter "T" and repeat as many times as there are tube connections on the fitting. **Example:** No. 12-16 DBT, Elbow; or No. 12-8-10 JBBBT, Tee.

Standard Type—To specify standard type fittings without tube nuts, use the same shape symbols as for Triple Type, except omit the letter "T" in all instances. **Example:** 12-8-10 J, Tee; or 20-16 F, Nipple. To specify standard type fittings with tube nuts, add the letter "B" as many times as there are tube connections on the fitting (omitting the letter "T"). **Example:** 12-8-10 JBBB, Tee; or 20-16 FB, Nipple.

WEIGHT STANDARD

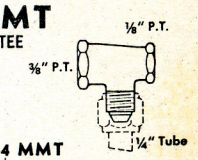
Shape symbols as shown are for "Standard Weight" fittings. For "Heavy Weight" fittings add "XX" to the shape symbol. **Example:** No. 6-2 CTXX, Elbow; or No. 12-8-12 RBBXX, Tee.

MATERIAL

Brass (or cast bronze) is always furnished when no material is specified. Other materials are specified by adding the proper material symbol after the shape symbol, as follows:

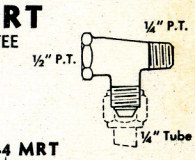
Aluminum Alloy	**-D**	(as No. 6-2 CT-D, Elbow)
Carbon Steel	**-S**	(as No. 12-8-10-8 KT-S, Cross)
Stainless Steel	**-SS**	(as No. 10-16 CT-45°-SS, 45° Elbow)
Nickel Steel	**-NS**	(as No. 24-20 HT-NS, Union)
Copper Silicon Alloy	**-CS**	(as No. 6 T-CS, Sleeve)

MMT
TEE



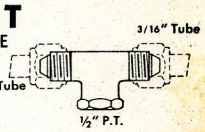
6-2-4 MMT
- 3rd—Side Tube Size
- 2nd—Smaller Run PT Size
- 1st—Larger Run PT Size

MRT
TEE



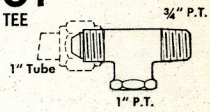
8-4-4 MRT
- 3rd—Side Tube Size
- 2nd—Run Ext. PT Size
- 1st—Run Int. PT Size

OT
TEE



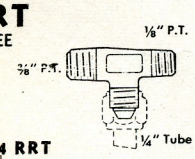
6-3-8 OT
- 3rd—Side PT Size
- 2nd—Smaller Run Tube Size
- 1st—Larger Run Tube Size

ROT
TEE



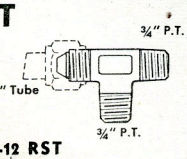
16-12-16 ROT
- 3rd—Side PT Size
- 2nd—Run PT Size
- 1st—Run Tube Size

RRT
TEE



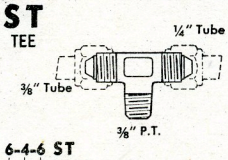
6-2-4 RRT
- 3rd—Side Tube Size
- 2nd—Smaller Run PT Size
- 1st—Larger Run PT Size

RST
TEE



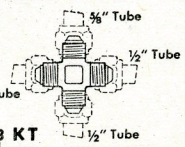
16-12-12 RST
- 3rd—Side PT Size
- 2nd—Run PT Size
- 1st—Run Tube Size

ST
TEE



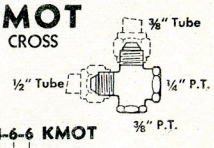
6-4-6 ST
- 3rd—Side PT Size
- 2nd—Smaller Run Tube Size
- 1st—Larger Run Tube Size

KT
CROSS



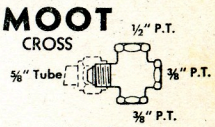
12-8-10-8 KT
- 4th, Bottom—Tube Size
- 3rd, Top—Larger vertical Tube
- 2nd, Right—Tube Size
- 1st, Left—Largest Tube Size

KMOT
CROSS



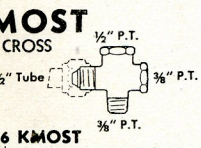
8-4-6-6 KMOT
- 4th, Bottom—PT Size
- 3rd, Top—Tube Size
- 2nd, Right—PT Size
- 1st, Left—Larger Tube Size

KMOOT
CROSS



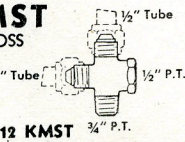
10-6-8-6 KMOOT
- 4th, Bottom—PT Size
- 3rd, Top—Larger vertical PT
- 2nd, Right—PT Size
- 1st, Left—Tube Size

KMOST
CROSS



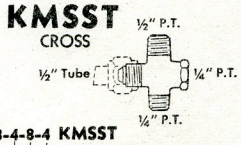
8-6-8-6 KMOST
- 4th, Bottom—Ext. PT Size
- 3rd, Top—Int. PT Size
- 2nd, Right—Int. PT Size
- 1st, Left—Tube Size

KMST
CROSS



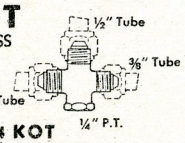
12-8-8-12 KMST
- 4th, Bottom—Ext. PT Size
- 3rd, Top—Int. PT Size
- 2nd, Right—Int. PT Size
- 1st, Left—Tube Size

KMSST
CROSS



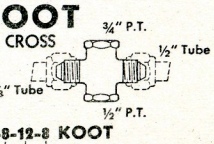
8-4-8-4 KMSST
- 4th, Bottom—Ext. PT Size
- 3rd, Top—Larger Ext. PT Size
- 2nd, Right—Int. PT Size
- 1st, Left—Tube Size

KOT
CROSS



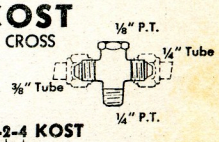
8-6-8-4 KOT
- 4th, Bottom—PT Size
- 3rd, Top—Tube Size
- 2nd, Right—Tube Size
- 1st, Left—Larger Run Tube Size

KOOT
CROSS



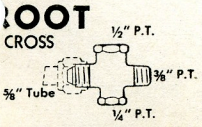
10-8-12-8 KOOT
- 4th, Bottom—PT Size
- 3rd, Top—Larger PT Size
- 2nd, Right—Tube Size
- 1st, Left—Larger Tube Size

KOST
CROSS



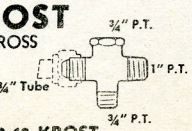
6-4-2-4 KOST
- 4th, Bottom—Ext. PT Size
- 3rd, Top—Int. PT Size
- 2nd, Right—Tube Size
- 1st, Left—Larger Tube Size

KROOT
CROSS



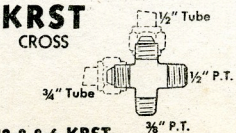
10-6-8-4 KROOT
- 4th, Bottom—Int. PT Size
- 3rd, Top—Larger Int. PT Size
- 2nd, Right—Ext. PT Size
- 1st, Left—Tube Size

KROST
CROSS



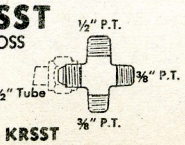
12-16-12-12 KROST
- 4th, Bottom—Ext. PT Size
- 3rd, Top—Int. PT Size
- 2nd, Right—Ext. PT Size
- 1st, Left—Tube Size

KRST
CROSS



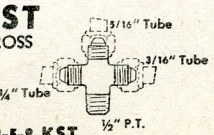
12-8-8-6 KRST
- 4th, Bottom—PT Size
- 3rd, Top—Smaller Tube Size
- 2nd, Right—PT Size
- 1st, Left—Larger Tube Size

KRSST
CROSS



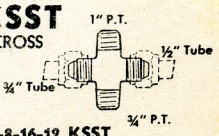
8-6-8-6 KRSST
- 4th, Bottom—PT Size
- 3rd, Top—Larger vertical PT
- 2nd, Right—PT Size
- 1st, Left—Tube Size

KST
CROSS



4-3-5-8 KST
- 4th, Bottom—PT Size
- 3rd, Top—Tube Size
- 2nd, Right—Tube Size
- 1st, Left—Larger Run Tube Size

KSST
CROSS



12-8-16-12 KSST
- 4th, Bottom—PT Size
- 3rd, Top—Larger PT Size
- 2nd, Right—Tube Size
- 1st, Left—Larger Tube Size

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

THE USE OF AIRCRAFT FITTINGS

I. OBJECT: CONNECTING TWO PIECES OF TUBING.

A. TWO PIECES OF TUBING OF THE SAME SIZE.

JOB: Demonstrate to the satisfaction of the instructor that you can use the proper fitting to join together two tubes of the same size.

PROCEDURE: To begin this series of jobs it will be necessary to go to the crib and obtain a box containing an assortment of hydraulic fittings. After you have this put the contents of the box on the table and disassemble any of the parts which may be fastened together. When your instructor is ready to have you start, select from the parts before you two pieces of No. 8 aluminum tubing and join them together with the proper fitting.

When you are finished, show your job to the instructor. Now use the table below to record the part numbers of the fittings you have used.

You will be given a copy of T.O. 00-45-1 in which may be found the correct name and part numbers of most of the fittings used in these exercises. These part numbers begin on Page 6 of the AN-AC-NAF CONVERSION CHARTS which follow Page 195 in the Technical Order. Check the names and numbers with your instructor before making a permanent entry in the spaces below. There should be 5 parts recorded for this job.

Quantity	NAME	PART NUMBER

B. TWO PIECES OF TUBING OF DIFFERENT SIZE.

JOB: Select the proper fittings for connecting two tubes of different size

PROCEDURE: Select one piece of No. 8 and one piece of No. 10 tubing and connect them with the fitting which you think should be used.

When checking the part number for the main fitting used in this connection, it will be necessary to check the Fittings Bins.

Check with the instructor when you have completed the job and, if it is correct, record the names and part numbers on the form on the following page.

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Quantity	NAME	PART NUMBER

II. OBJECT: CONNECTING TOGETHER THREE PIECES OF TUBING.

A. JOB: Select three pieces of No. 8 tubing from the parts on the table and use the proper fittings for the connection.

PROCEDURE: Select the proper fittings for the job and have the instructor check your result. If the job is O.K., record the names of the fittings and their part numbers in the form provided.

Quantity	NAME	PART NUMBER

B. JOB: Select three pieces of tubing of different size and connect them together. Use one No. 10 and two pieces of No. 8.

PROCEDURE: Select two pieces of No. 8 tubing and one of No. 10 and use the proper fitting for the connection. Consult the Fittings Chart in your Manual and check the method used in designating a Tee fitting with different size outlets. Consult your instructor if the chart is not self-explanatory. When you have learned the method of designating sizes record the complete list of parts used in the table below.

Quantity	NAME	PART NUMBER

State the rule in designating the sizes on the outlet ports of a tee.

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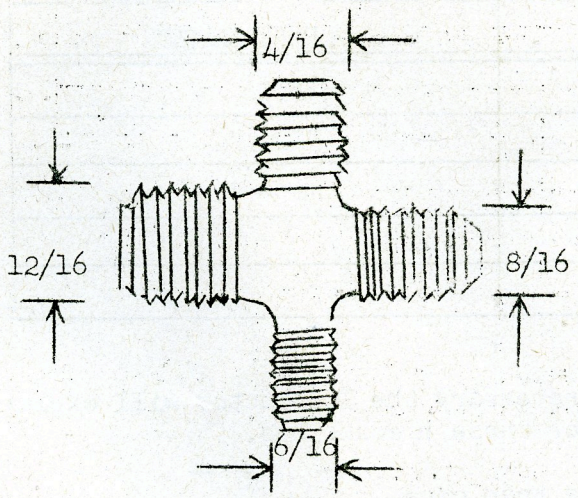
III. OBJECT: CONNECTING TOGETHER FOUR TUBES.

A. JOB: To join together four tubes of equal size.

PROCEDURE: Select 4 tubes of equal size from the parts on the table and choose the proper fitting for joining them together. When you have checked your job with the instructor, enter the names and part numbers in the columns below.

Quantity	NAME	PART NUMBER

B. What is the accepted method of designating sizes on a KT Cross fitting when the port sizes are not equal? Answer this question by writing the part number for the fitting shown in the sketch below.



Part Number: _____

IV. OBJECT: JOINING ONE TUBE TO A UNIT.

A. JOB: Join one straight tube to a unit. Make the connection straight in, that is, at an angle of 180°.

PROCEDURE: Ask the instructor for a unit to which you may attach either a piece of No. 8 or No. 10 tubing. Use the fittings necessary in the manner in which you think the tube should be connected. Make a list of the parts used in the form below:

Quantity	NAME	PART NUMBER

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B. JOB: Join one straight tube to a unit at an angle of 90°.

PROCEDURE: Use the fittings on the table to connect the tube to the unit used in the previous exercise. Make sure that the tube comes in at an angle of 90 degrees. List the fittings used in the column below.

Quantity	NAME	PART NUMBER

V. OBJECT: CONNECTING TWO TUBES TO A SINGLE PORT OF THE SAME UNIT.

List the name and part number of each fitting used.

Quantity	NAME	PART NUMBER

PRECAUTIONS TO BE OBSERVED: Wherever necessary the Instructor will explain the reasons for these precautions.

1. Don't use a crush gasket more than once.
2. Don't use two crush gaskets in the same place at the same time.
3. Don't over-torque BT Nuts. You will injure the tube flare. (Consult Table)
4. Don't try to connect a tube to a unit by use of a standard union (AC 811-HT-)
5. Don't use a pipe-thread fitting where the unit calls for straight thread.
6. Don't damage serrations on fittings or ports. Damaged serrations cause leakage.
7. Don't attempt to loosen BT Nut on a fitting without holding fitting.
8. Don't use the wrong size wrench. You are working with soft metal.

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TESTING OF HYDRAULIC UNITS: Your work in connection with testing of units on the Hydraulic Test Stand will be judged on the following basis:

1. Ability to make proper hook-up for testing.
2. Selection of proper fittings in making connections.
3. Care with which tubing, fittings, and units are handled.
4. Condition in which units and test stand are left upon completion of test.

TORQUE FOR BT NUTS ON HYDRAULIC TUBING

Size Tubing	Material	Torque Required
1/4 inch	Steel Tubing	50-90 inch-pounds
1/4 "	Alum. "	40-65 " "
5/16 "	" "	60-80 " "
3/8 "	" "	75-125 " "
1/2 "	" "	150-250 " "
5/8 "	" "	200-350 " "
3/4 "	" "	300-500 " "
1 "	" "	500-750 " "

Airplane & Engine Mech Course (Special B-24)
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THREAD COMPOUNDS--FORD STANDARDS

1. The following thread compounds are approved for use in the installations indicated. (May 15, 1944)

STRAIGHT THREADS

Installation	Ford M. No.	Compound	AAF Spec.
Air Speed	M-595	Petrolatum	AN-VV-P-236
Anti-Icing	M-3843	Isopropyl Alcohol	AN-F-13
De-Icer (Air)	M-595	Petrolatum	AN-VV-P-236
Fire Extinguisher	M-595	Petrolatum	AN-VV-P-236
Hydraulic	M-4766	Hydraulic Oil	AN-VV-O-366B
Vacuum	M-595	Petrolatum	AN-VV-P-236
Water	M-595	Petrolatum	AN-VV-P-236
Conduit	M-4685	Zinc Dust Comp.	None
Al. Alloy Bolts	M-4685	Zinc Dust Comp	None
Fuel System	M-595	Petrolatum	AN-VV-P-236
Heater System		Crane Lead Seal	None
Oil System	M-4846G	Engine Oil	AN-VV-O-446A Grade 1120
Oxygen System		Rectorseal # 15	AN-C-86

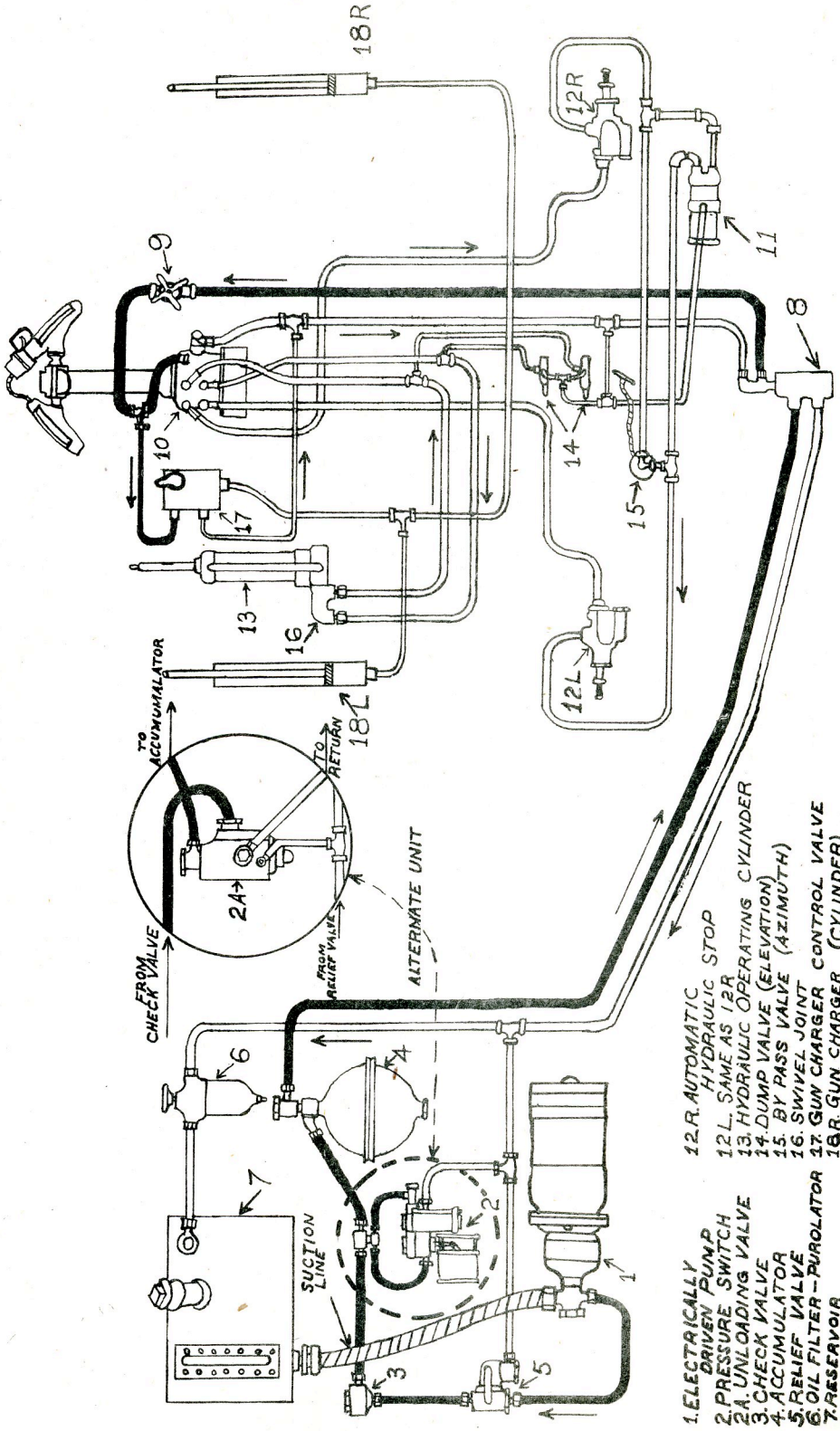
PIPE THREADS

Installation	Ford M. No.	Compound	AAF Spec.
Air Speed	M-4853	White Lead Compound	AN-C-53
Anti-Icing	M-4853	White Lead Compound	AN-C-53
De-Icer (Air)	M-4853	White Lead Compound	AN-C-53
Fire Extinguisher	M-4853	White Lead Compound	AN-C-53
Hydraulic	M-4853	White Lead Compound	AN-C-53
Vacuum	M-4853	White Lead Compound	AN-C-53
Water	M-4853	White Lead Compound	AN-C-53
Fuel System	M-4679	Parker Sealube	None
Heater System		Crane Lead Seal	None
Oil System	M-4679	Parker Sealube	None
Oxygen System		Rectorseal # 15	AN-C-86

2. Apply compound to the first three (3) threads of the male fittings only---on all thread connections. Caution shall be exercised to insure that the compound is carefully and sparingly used, making sure that none of the compound enters the system.

3. All anti-seizes and sealing compounds shall be kept well-covered when not in use----also properly identified.

TAIL TURRET HYDRAULIC SYSTEM



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FORD AIRPLANE SCHOOL

REAR TURRET

Aim:

To become familiar with the location, operation, and inspection of the rear turret actuating system.

References:

T.O. 11-45D-1

Basic Information:

The rear turret on the B-24 is actuated by an hydraulic system independent of the main hydraulic system of the ship. Accumulator pressure, created by the electrically driven gear type pump, (later turrets have a Vickers piston pump) is transmitted to the actuating units through control valves which are operated by the gunner in firing position. In case of hydraulic failure the guns and turret may be operated manually.

Procedure:

A. Location of Units

1. List in proper order, all units through which hydraulic fluid passes in the azimuth operation of turret.

1.	Pump	9.	_____
2.	_____	10.	_____
3.	_____	11.	_____
4.	_____	12.	_____
5.	_____	13.	_____
6.	_____	14.	_____
7.	_____	15.	Reservoir
8.	_____		

2. In the zenith operation of the guns what three units are eliminated from the above list?

1. _____
2. _____
3. _____

What units would be added?

1. _____
2. _____

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REAR TURRET (Cont'd)

3. What unit replaces the fluid motor in the later turrets?

   1. _____

4. How many hydraulic cylinders are used to raise and lower guns in the later turrets.

   1. _____

B. Operation:

1. What precaution should be heeded by the gunner when leaving the turret?

2. What does this do to the hydraulic fluid in the pressure line?

3. Why should this precaution be strictly adhered to?

4. What is the function of the Control Valve?

5. What two valves should be checked when entering the turret?

6. In case of hydraulic failure, how may the turret be operated?

7. How can an injured gunner be removed by a crew member when turret is turned in such a way that doors do not open?

8. What becomes of the hydraulic fluid in the pressure line when the emergency by-pass valve is opened?

9. State the purpose of the two automatic hydraulic stops.

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REAR TURRET (Con'd)

C. Inspection:

1. Pressure settings, etc.

   a. Type of Pump: (a) Old_____ (b) New_____

   b. Relief valve setting _____

   c. Settings of Unloading Valve _____

   d. Accumulator air pressure _____

2. What precaution should be taken when removing the accumulator?

3. Should the oil or air pressure be relieved first?

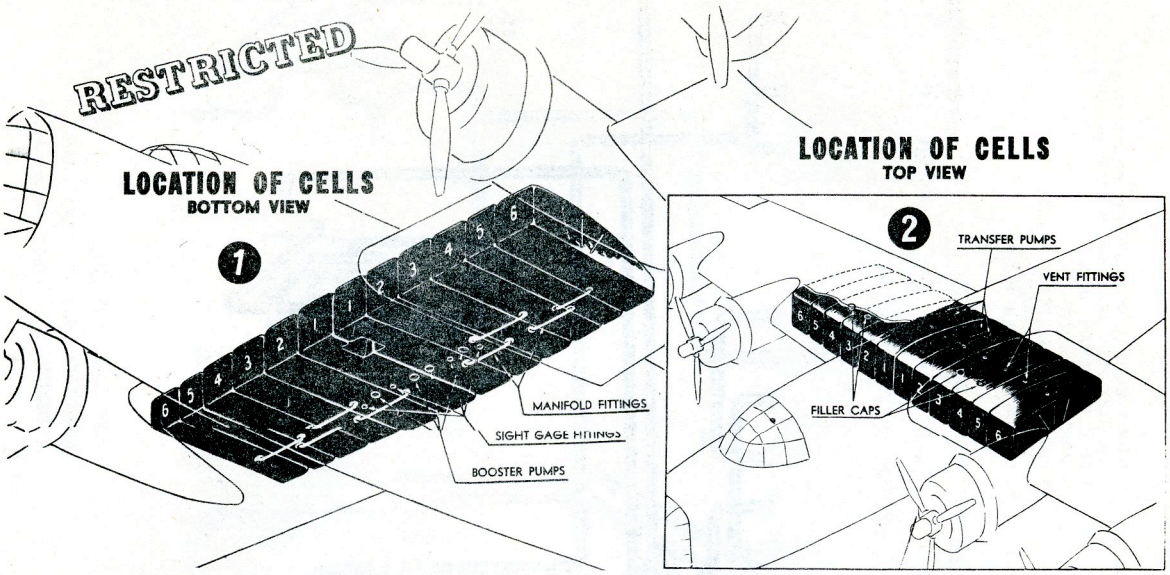
4. How often should handle on the Purolator filter be turned?

   How often should the sump on filter be cleaned?

5. What fluid level should be maintained in the reservoir?

6. What specification of fluid is used?

RESTRICTED



SUGGESTED METHOD OF REMOVING AND INSTALLING MAIN WING CELLS CONSOLIDATED B-24

REMOVING CELLS

1. Drain gasoline (refer to Technical Order 01-5EC-2, Page 167).
2. If all fuel cells are to be removed, cell No. 3 (see figure No. 1) should be removed first. If fuel cells No. 1 or No. 2 are to be removed, No. 3 should be removed first. If cells No. 4, 5, 6 are to be removed, No. 4 should be removed first.
   This is accomplished by removing the small and large access doors. This is most easily done by removing both doors as one unit. These doors are plainly visible on the underneath side of the wing between a point inside the inboard engine nacelle and the center line of the airplane.
   Remove manifold inspection plates and loosen hose clamp on cell fitting side only.
   Slip the metal connector tube out of the cell fitting only by pulling down slightly while working metal connector from side to side.
   Suggestion: If metal connector has a tendency to stick, loosen by squirting benzene around metal connector tube. Do not use sharp instrument to pry on rubber fitting.
3. Remove metal tank bed plates.
4. Remove metal stiffener rod (see figure No. 6) from each side of No. 3 cell.
   This may be done by cutting the stitching at the bottom of each stiffener tunnel.
5. Remove filler cap and safety chain located on upper surface of wing (see figure No. 2).
6. Remove counter sunk screws that hold cell filler neck to upper surface of wing.
7. It is possible to loosen vent fitting connector (see figure No. 2) from top of fuel cell by working through filler neck opening on upper surface of the wing or by working from underneath the wing.
   When working from underneath the wing it is necessary to partially collapse the bottom side of cell sideways and pull down slightly from the top so that vent fitting can be reached.
   Be sure to disconnect bellows vent hose from fuel cell only.
8. Cell No. 3 can now be removed by passing two web or leather straps around the cell as far each way from center as possible, then pull down into a collapsed position.
   Secure straps to maintain cell in collapsed position (see figure No. 3).
9. Push center of collapsed cell to top of wing cavity (see figure No. 4). At the same time pull forward end of cell back to access door opening. This will allow forward section of cell to drop toward the ground.
   Cell may then be completely removed by pushing back end of cell up and pulling complete cell forward (see figure No. 5).
10. To remove other cells take out canvas bulkhead curtains.
11. Cell No. 4 can then be removed in the same manner as cell No. 3.
12. Cell No. 5 does not have a filler fitting but otherwise can be removed in the same manner as cell No. 3 and No. 4.
13. When removing cell No. 6 disconnect manifold and vent fittings by same method as used for cells No. 4 and No. 5.
    Remove center truss member from bulkhead No. 5.
    On cell No. 6 it is necessary to remove top stiffener rods before side stiffeners can be removed. (See figure No. 6 for location of top stiffeners.)
    After top stiffener rods have been removed, side stiffeners can be removed by rolling cell from side to side and removing side stiffener rods from the top side of the cell.
    Place one web strap around cell at forward end of access door, and one strap around cell at back edge of access door.
    Collapse cell and secure in collapsed position.
    Three men will now be required to complete the collapsing of this cell and to turn the cell on its side so that the bottom of the cell is facing the workmen.
    One man is necessary to collapse and help turn forward end of cell.
    Second man to collapse and turn rear end of cell.
    Third man to turn center of cell.
    After the cell has been turned on edge, the center portion of the cell should be pushed toward the wing tip or outboard side of wing cavity as far as possible.
    Front end of cell should then be pulled toward center of cell and out through bulkhead opening.
    It will then be possible to continue removal of the cell through the access opening under cell No. 5.
14. To remove cell No. 2 remove manifold and vent fitting same as cell No. 3. Remove stiffener rods same as cell No. 3.
    Remove bomb release control rods, remove sight gauge fittings, remove booster pump and studs, disconnect transfer tube and hose fittings from the top of the wing inside the fuselage; then remove nut fitting which holds top of fuel cell No. 2 in position. (See figures No. 1 and 2.)
    Place two web straps around center of cell as far apart as possible.
    Collapse cell and secure in collapsed position. (See figure No. 3.)
    Push center of collapsed cell upward as far as possible.
    Pull forward end of cell back until it is over access opening. (See figure No. 4.)
    Turn forward end of cell so that top of cell faces toward the center of the airplane in order to clear fuselage and control cables.
    Pull down and remove through bombay opening.
15. To remove cell No. 1 it is necessary to take out removable center truss member from bulkhead No. 1.
    Remove fittings and stiffeners on cell No. 1 in the same way as cell No. 2.
    In addition it will be necessary to remove stiffener rods on the top of cell No. 1.
    Cell can then be partially collapsed sideways by pulling back side of cell toward workman so that stiffener rods on the far side of the cell can be removed over the top of the cell. Cell No. 1 can then be collapsed the same as cell No. 2 except that in removing the cell, the rear end of the cell should be pulled forward.
    As the rear end of the cell is pulled forward it should be turned so that the cell can be removed through the access door under cell No. 2.

INSTALLING CELLS

Generally speaking, all cells can be installed by reversing the removal procedure. There are, however, certain differences which are listed below:

1. It will be necessary to use four web straps to hold cell in collapsed position. (See figure No. 8.)
2. After cells No. 1 and No. 6 have been installed make certain that the removable bulkhead trusses are replaced in their correct positions and securely fastened.
3. The last cell installed, whether it be No. 3 or No. 4 should have web strap buckles on the bottom of the cell.
   This is necessary to facilitate removal of the strap.
4. When the last cell with buckles on bottom is in place in wing cavity, push center of cell toward the top of the wing cavity and remove web straps No. 1 and No. 4. (See figure No. 8.)
5. Occasionally some cells will require the use of plywood shims to take up space between the front face of the cell and the front spar bed plate. (See figure No. 4.)
   When this is necessary to correct cell length variations the cell will be so marked and plywood shims will be included in the cell carton. Maximum space allowable without use of shims must not exceed one-half inch.
6. Rubber protector strip included in cell carton should be placed over the edges of the bed plate and metal see stringer. (See figure No. 9.)
   This stringer is located immediately forward of the rubber manifold fitting. Protector strip is used to protect manifold fitting from contact with sharp edge of see stringer.
7. It has been found that certain simple tools will facilitate the lining up of the cell fittings and wing skin.
   Instructions for making these tools are shown in figures No. 10 and 11.
   Instructions for use of tools are shown in figures No. 10 and 11.
   Caution: Pad ends of steel bar used to make tool in figure No. 11 by wrapping each end with tape.

COLLAPSING CELLS

1. Remove side stiffener rods (see figure No. 6).
2. Place four web straps under cell (see figure No. 7).
3. Collapse cell by applying pressure with knee to side and end of cell and applying pressure to the top of cell with the left hand at the same time tucking forward end of cell inward. (See figure No. 7.)
4. Cell should then be secured in collapsed position as in figure No. 8.

CAUTION

1. Whenever possible, warm cell to room temperature. (approximately 65° to 100°) before collapsing. Do not allow cell to remain in collapsed condition for more than thirty minutes.
2. Do not bend cell at inspection door or at any point where rubber fittings adjoin cells.
3. Stiffener rods may be most easily replaced by coating with soapy water. Do not drive into place and do not use oil or grease.
4. Install booster pump carefully so that rubber gasket is not damaged. This is very important.
   If gasket is damaged replace with part No. 32C15516.
5. Do not pry on rubber fittings or cells with sharp instruments of any kind.
6. For fuel cell repair procedure see Technical Order 03-10-26 and 03-10-27.
7. **Do not lift fuel cells by their fittings. Do not allow cells to rest on fittings.**
8. Be sure that all openings are covered while cell is out of airplane.

THESE INSTRUCTIONS ARE INTENDED FOR FIELD INSTALLATIONS AND REMOVALS ONLY. THEY ARE NOT INTENDED FOR FACTORY INSTALLATIONS

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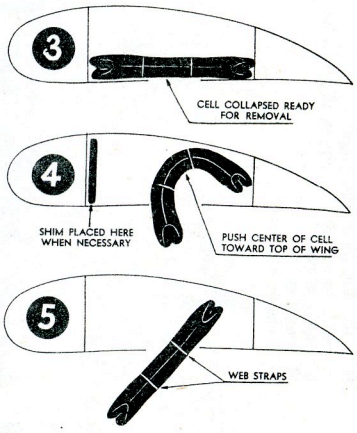
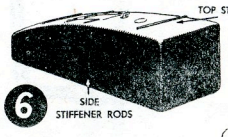
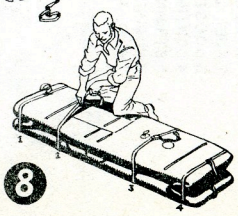
REMOVING CELL

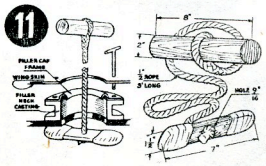


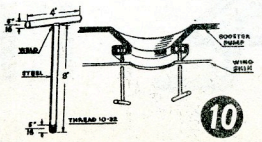
COLLAPSING CELL





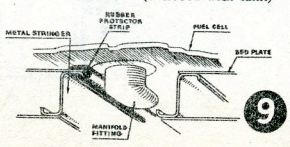
TOOLS FOR INSTALLING CELLS





INSTALLING RUBBER PROTECTOR STRIP

(enclosed with tank)



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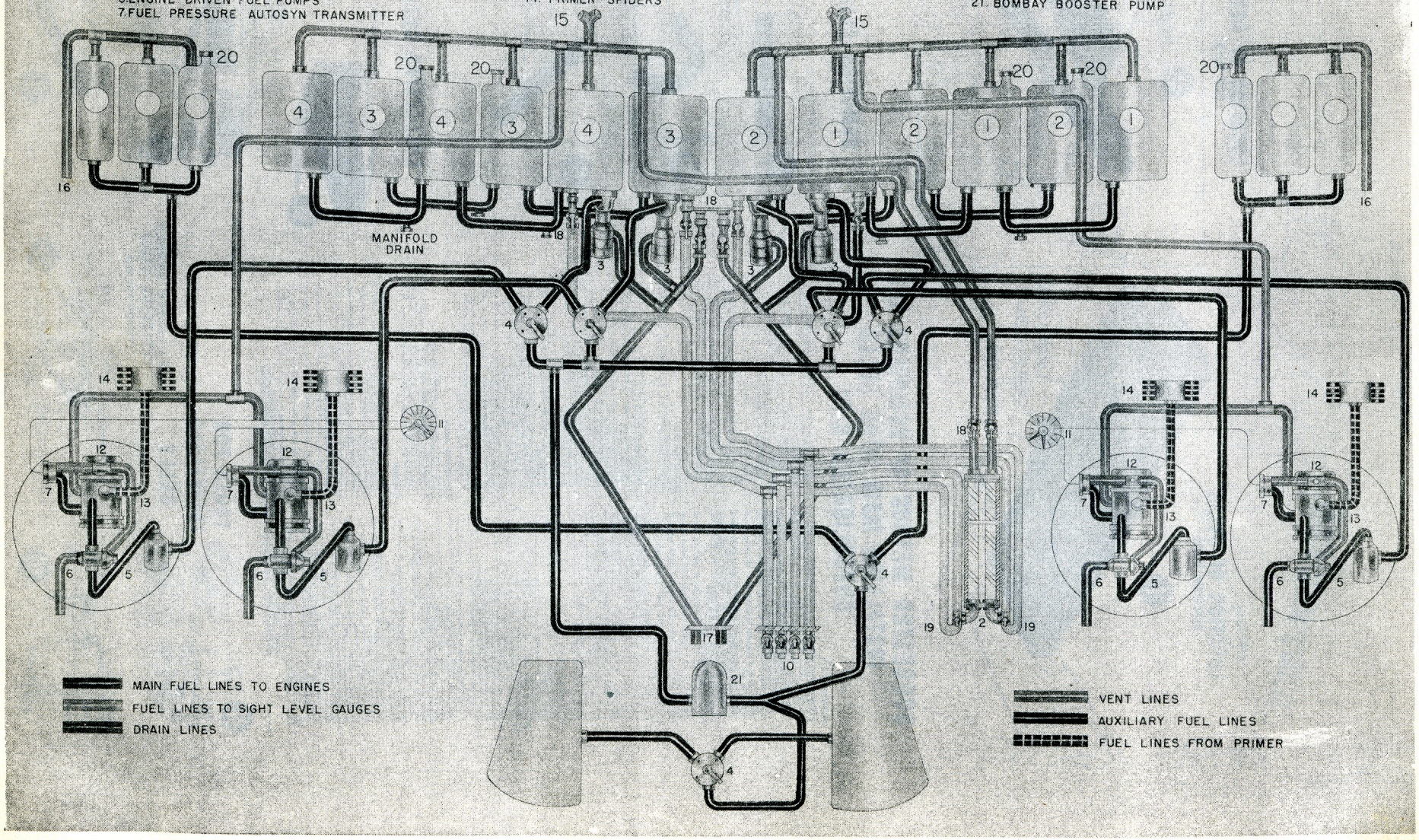
FUEL SYSTEM

DESCRIPTION AND UNIT NUMBERS

1. MAIN FUEL CELLS, 1 TO 6, R & L
   AUXILIARY FUEL CELLS, 7 TO 9, R & L
2. FUEL LEVEL SIGHT GAUGES
3. BOOSTER PUMPS
4. CONTROL VALVES
5. STRAINERS
6. ENGINE DRIVEN FUEL PUMPS
7. FUEL PRESSURE AUTOSYN TRANSMITTER
8. FUEL TRANSFER MAIN PANEL
9. AUXILIARY FUEL TRANSFER PANEL
10. FUEL GAUGE SUMP DRAIN
11. FUEL PRESSURE AUTOSYN INDICATORS
12. CARBURETORS
13. PRIMERS
14. PRIMER SPIDERS
15. MAIN FUEL CELL VENT SYSTEM, OUTLET & INLET
16. AUXILIARY FUEL CELL VENT SYSTEM, OUTLET
17. CELL BAY DRAIN LINES
18. SHUT-OFF VALVES
19. FUEL GAUGE SELECTOR VALVES
20. FUEL FILLER OPENINGS
21. BOMBAY BOOSTER PUMP



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FORD AIRPLANE SCHOOL

FUEL SYSTEM STUDY SUMMARY

General Tech. Orders: 01-5EC-1, 01-5EC-2, 01-5EE-1.

UNITS	INFORMATION
Fuels T.O.06-5-1 01-5-75A 03-10-9 12-1-10 02-1-38	1. 100 Octane and 91 Octane gasoline 2. Aromatic type of fuel 3. Avoid lengthy exposure to the gas fumes 4. Keep fire away from fuels.
Filler Fittings T.O. 01-5-58	1. Located on top surface of wing between inboard engines and fuselage. 2. Filler caps located on cells #3 and #4 on each side of the plane. 3. Filler cap for auxiliary tanks is located on top of the wing immediately behind the nacelles of the outboard engines and is attached to cell #7.
Fuel Vent System	1. An outlet for air confined within the fuel cells is necessary. 2. There is a common vent line for cells in each wing. (main cells) 3. Maintains atmospheric pressure above the fuel 4. Main fuel cell vent outlets are about 3" above the wing on each side of the fuselage (a) This outlet consists of two tubes forming a "Y" inside the fuselage. One tube comes straight out and the other curves forward as it protrudes from the fuselage. 5. The carburetor and fuel gages also vent into the main fuel cell vent manifold.
Drains on fuel cells.	1. The early models with no cross feed or common manifold to the selector valves had drains in the bottom of each selector valve. 2. Later models with a common manifold for the selector valves were drained from the cross feed line with the use of the booster pumps. PLANE MUST BE GROUNDED WHEN DRAINING GASOLINE! 3. There is an individual drain valve for each of the four systems that provides for the drainage of dirt or water. These lines also lead to the sight gages. 4. These drain valves may be found in the fore part of the bomb bay on the left hand side. 5. At least a quart should be drained from each of these valves every day.

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FUEL SYSTEM STUDY SUMMARY (CONT'D.)

UNITS	INFORMATION
Fuel Sight gages T.O. 03-10-15	1. Sight gages are located at the forward face of bulkhead at station 4.1. 2. The reading is correct only when taken with the inclinometer reading at ZERO. 3. By setting the two-way valve located at the bottom of the gage, the quantity of fuel in any of the four main fuel systems may be determined. 4. Horizontal position ----------back ports Vertical position ----------front ports 5. Front ports ----------inboard cells Back ports ----------outboard cells 6. These gages are vented to the main fuel cell vent.
Booster pump system T.O. 03-10EC-2	1. A booster pump is installed in each of the four main fuel systems at the bottom of cells #1 and #2 on each side. 2. The purpose is to deliver a positive flow of fuel to the engine driven pump. 3. Booster pumps should always be used at take-off, landing and when above 10,000 ft. 4. They prevent vapor locks that may occur because of heat or a bend in the tubing, or low atmospheric pressu 5. Fuel may pass through these centrifugal pumps when they are idle. 6. Switches for the pumps are located on the lower left side of the Co-pilot's instrument panel.
Fuel selector valves T.O. 03-10-13	1. The fuel is carried from the booster pump to the selector valve in a large self-sealing hose. 2. The selector valve is designed to direct the flow of fuel from the tank to (a) Engine, (b) Cross feed, or (c) Both. 3. The valve has three ports (a) Engine, (b) Tank, (c) Cross feed. 4. There are four settings that may be made on the valve (1) Off, (2) Tank to engine, (3) Cross feed to engine, (4) Cross feed and tank to engine. 5. Before each flight be sure the setting is <u>tank to engine.</u> 6. Each selector valve designates the engine that it directs the fluid to, i.e. #2 Tank to #2 Engine. 7. Selector valves are also used in connection with the transfer panels and the bomb bay and auxiliary tanks.

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UNITS	INFORMATION
Bomb Bay Tanks	1. Used only when transporting planes long distances. 2. Only on the later planes can these tanks be dropped when empty. 3. Flow of fuel from bomb bay tanks to main tanks; both tanks are attached to a selector valve on the catwalk at station 5.0. Fuel can be drawn from only one or both tanks at the same time. From the selector valve the fuel goes to the catwalk pump (vane type) which forces it into the crossfeed line from where it may go into one or more main tanks or to one or more engines, depending on the setting of the main line selector valves. 4. Each tank will hold approximately 400 gallons.
Strainers	1. Booster Pump Strainers - located above each booster pump inside the main fuel cells. 2. C-4 strainer - there is one on the main fuel line to each engine. It strains the fuel just prior to its coming to the engine fuel pump. In the earlier transfer systems there is also one on the auxiliary tank panel.
Fuel Transfer System I U-Hose Panel	1. This transfer system consists of a panel with six ports which can be inter-connected by means of detachable U-hoses. The ports represent (1) Pump inlet, (2) Pump Outlet, (3) Right inboard tank, (4) Left inboard tank, (5) Right outboard tank, and (6) Left outboard tank. 2. An auxiliary tank panel has a selector valve, flow indicator, C-4 strainer, and an open port with a line disconnect valve on it. 3. With this system fuel may be transferred from any main tank to any other main tank, or from the auxiliary tanks to any main tank. Fuel from the bomb bay tank is transferred directly into the crossfeed line by means of a pump on the cat-walk.

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UNITS	MOTIVATING INFORMATION
Fuel Transfer System II Selector Valve Panel Type (Ford Built B-24E)	1. Instead of the U-hose panel as in Type I there is a panel with 2 selector valves on it. The settings on these valves determines where the fuel will be transferred. The Auxiliary Panel is the same as in Type I. 2. Fuel can be transferred from Outboard tanks or Auxiliary tanks to inboard tanks. Fuel can not be transferred into the outboard tanks except by using the crossfeed line. 3. Fuel from bomb bay tanks is transferred through the crossfeed by means of a pump on the catwalk.
Fuel Transfer System III Selector Valve Panel Type (Consolidated B-24J)	1. The transfer panel consists of two selector valves which are attached to the four main wing tanks and the outlet of the pump. There is also an auxiliary tank panel as in Types I and II. 2. This transfer unit can be used only for transferring fuel from the auxiliary tanks to the main tanks. The only way fuel can be transferred from one main tank to another is by means of the crossfeed line and the booster pumps. 3. Fuel from bomb bay tanks is transferred through the crossfeed by means of a pump on the catwalk.
Fuel Transfer System IV Centralized Selector Valve System (B-24H and Ford Built B-24J)	1. This system eliminates completely the transfer unit above the center wing. All transferring is done by means of the crossfeed line and the pump on the bomb bay catwalk. 2. The four main tank selector valves and auxiliary tank selector valve are all mounted on a common panel at Station 4.1 just to the left of the fuel sight gages. 3. Fuel from the auxiliary tanks and bomb bay tanks is transferred to the main tanks through the crossfeed by means of the pump on the catwalk, Sta. 5.0. 4. Fuel is transferred from one main tank to another through the crossfeed by use of the booster pumps.

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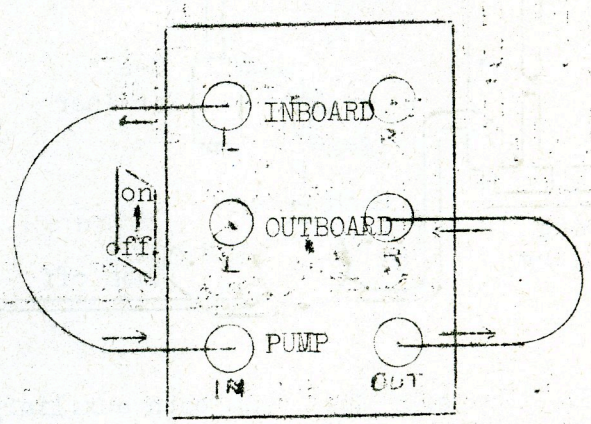
FUEL TRANSFER PROBLEMS I
(IN FLIGHT)

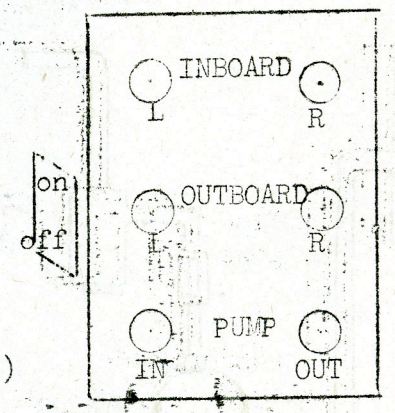
Type I - U-Hose Panel:

All ships previous to the 401 series (Ford built) used a transfer unit which made it possible to transfer fuel from any one tank to any other main tank. When the auxiliary wing tanks were installed, fuel from these was transferred through this same unit.

Example: Transfer fuel from the left inboard to the right outboard tank. (Follow arrows on diagram.)



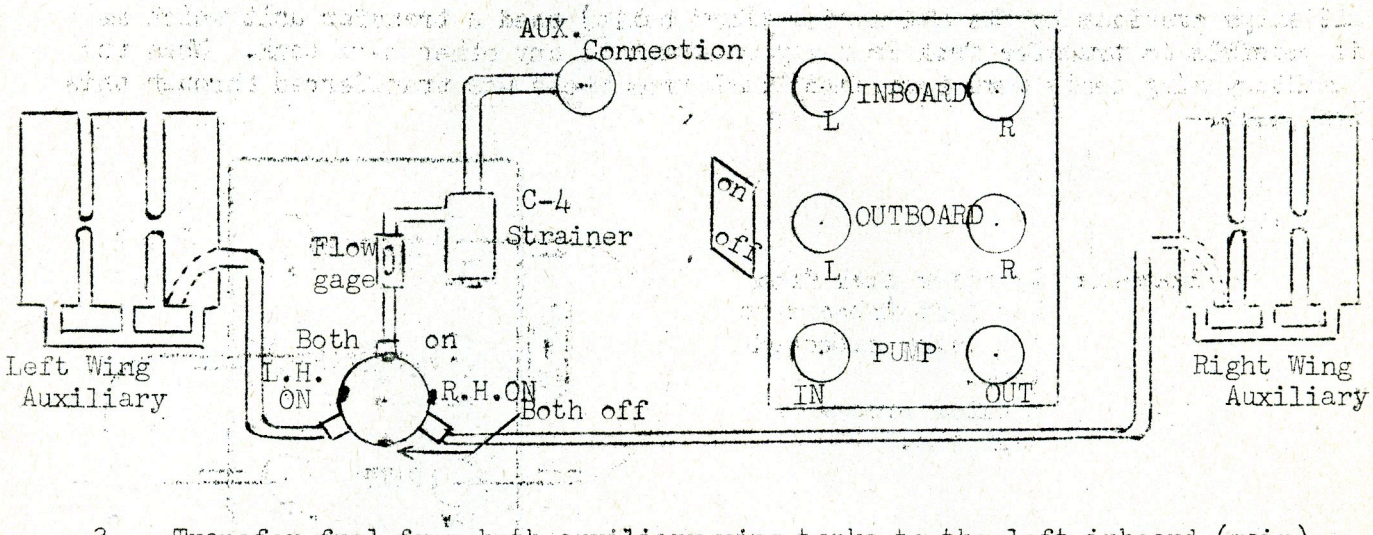
1. Transfer fuel from the right outboard tank to the left inboard. (Indicate the hook-up of the detachable hose and flow of the fuel by means of lines and arrows on the diagram.)



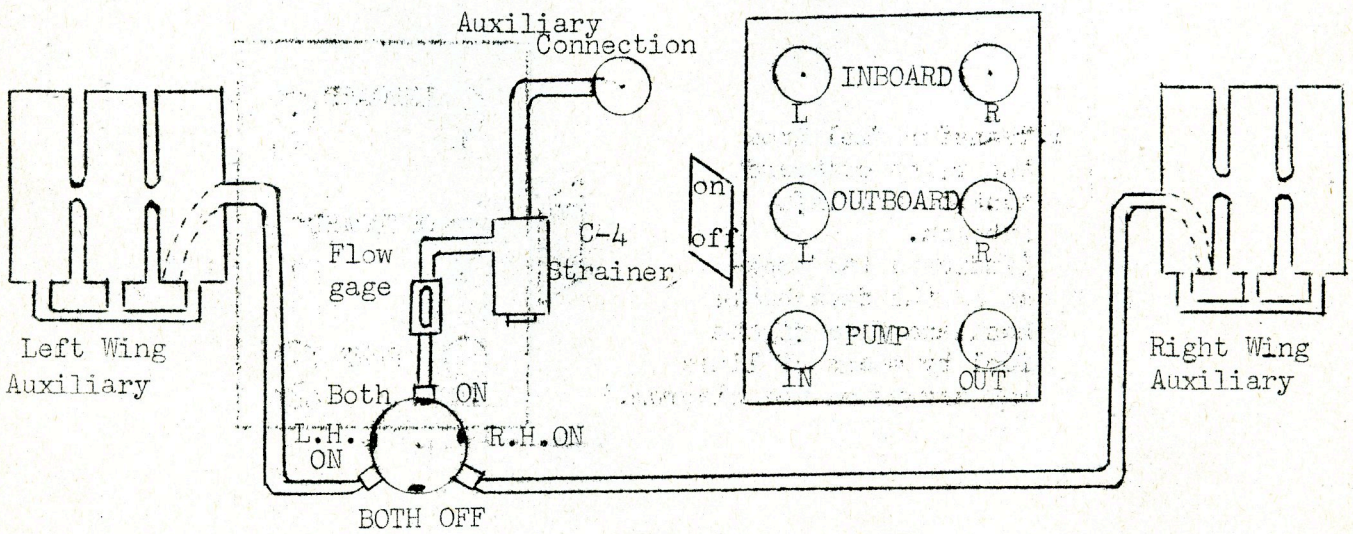
NOTE:

In the next two problems the auxiliary wing tanks have been added to the drawings. The auxiliary tank selector valve panel is also shown. Use an arrow to make the proper selection on the selector valve and draw lines to indicate the proper connections to the transfer panel.

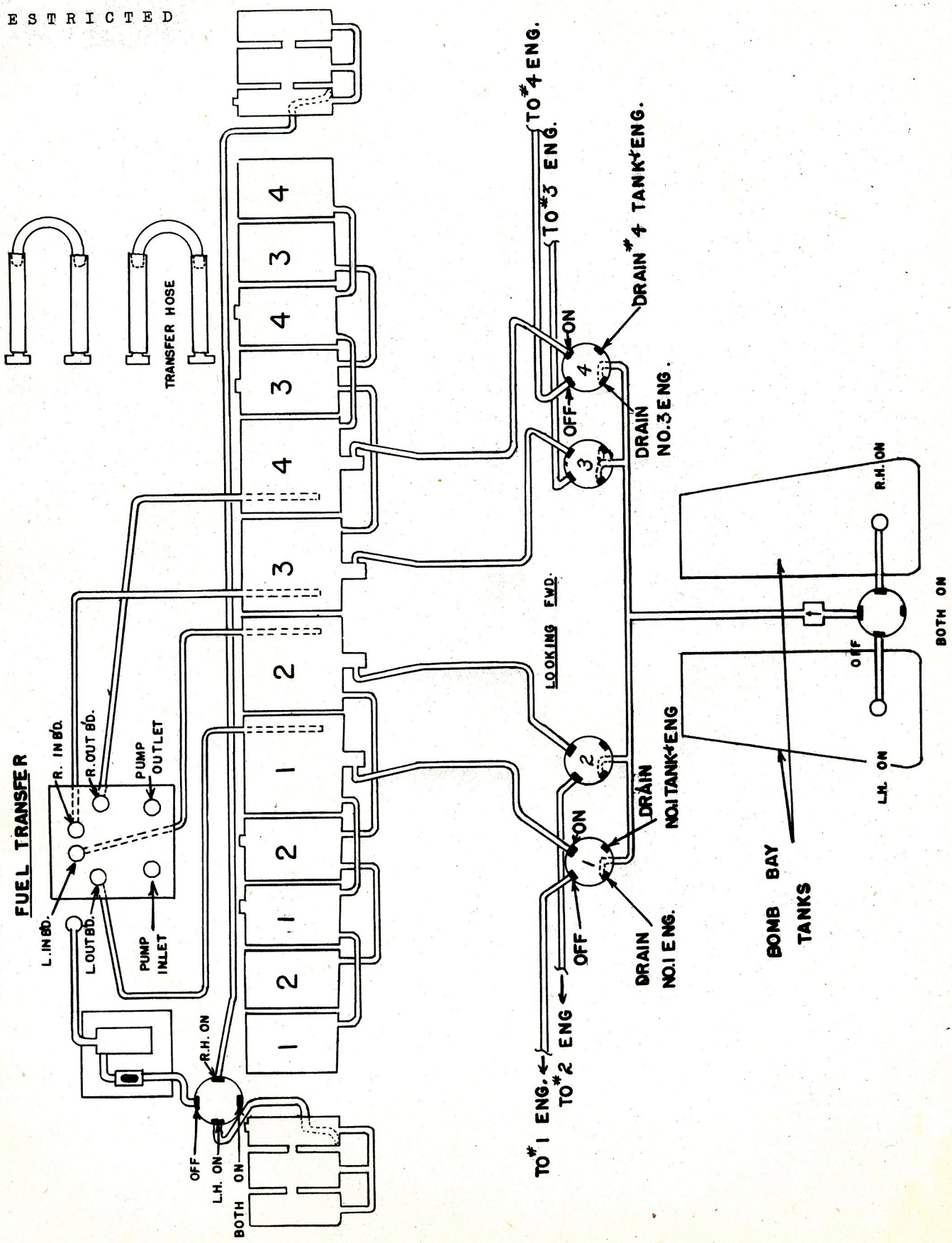
2. Transfer left auxiliary wing tank fuel to right inboard (main) tank.



3. Transfer fuel from both auxiliary wing tanks to the left inboard (main) tank.



4. Using the schematic of this transfer system as a problem answer sheet, transfer fuel from No. 2 Main Tank to No. 3 Main Tank using the cross-feed and Hose panel simultaneously. (See next page for Schematic).


FUEL TRANSFER
R. IN BD.
R. OUT BD.
PUMP OUTLET
L. IN BD.
L. OUT BD.
PUMP INLET
TRANSFER HOSE
R.H. ON
OFF
L.H. ON
BOTH ON
TO #1 ENG.
TO #2 ENG
TO #3 ENG.
TO #4 ENG.
LOOKING FWD.
ON
OFF
DRAIN #4 TANK & ENG.
DRAIN NO.3 ENG.
DRAIN NO.1 TANK & ENG
DRAIN NO.1 ENG.
BOMB BAY TANKS
R.H. ON
OFF
L.H. ON
BOTH ON

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FORD AIRPLANE SCHOOL

SUMMARY QUESTIONS - I

1. Why is it necessary to make a test pull on the transfer hoses before turning on the switch to the transfer motor?

2. Is the switch for the transfer motor located on the Co-Pilot's instrument panel? If not, state the location.

3. How is fuel taken from the bomb bay auxiliary tanks in this system?

4. Can fuel be transferred to the auxiliary wing tanks from the main cells?

5. Is it necessary to use the cross-feed manifold when transferring fuel by the auxiliary transfer panel?

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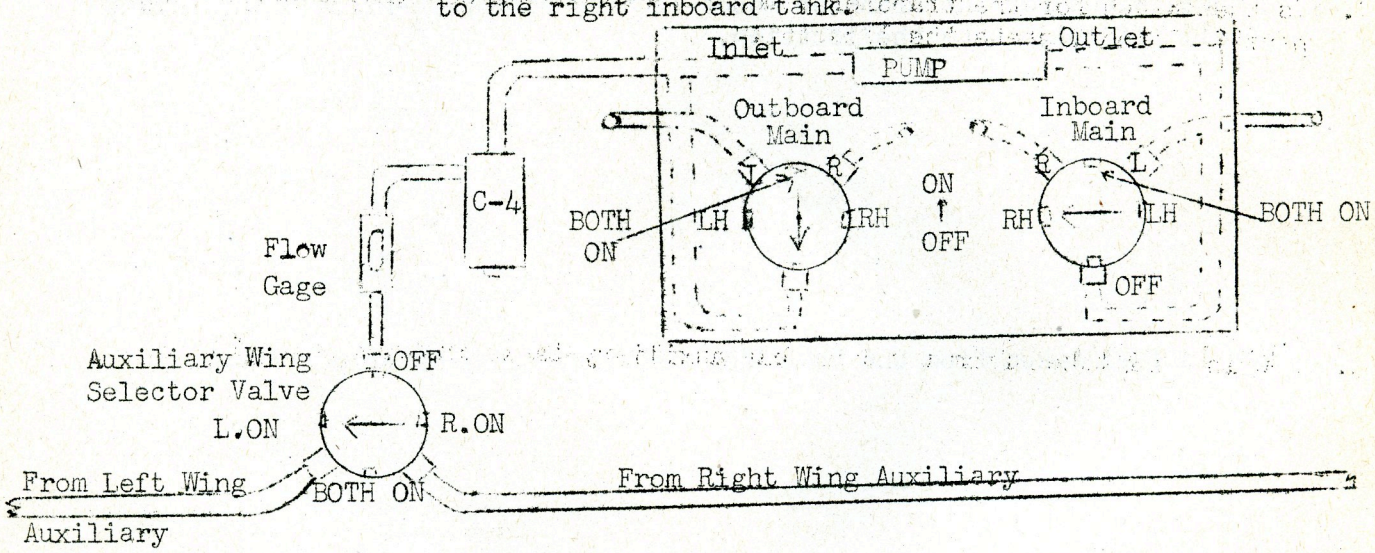
FUEL TRANSFER PROBLEMS II
(IN FLIGHT)

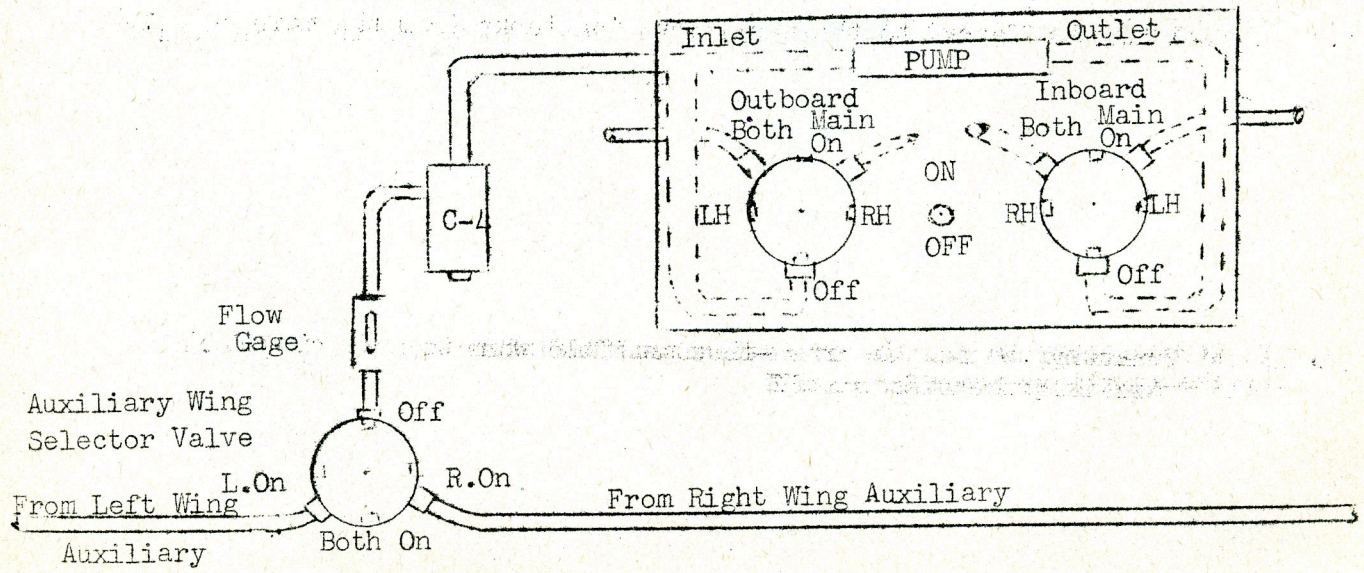
Type II - Selector Valve Panel Transfer System (Ford Built B-24E)

All ships in series 401 to 801 use a transfer unit which can only transfer fuel from outboard main tanks to inboard main tanks, and from the wing auxiliary tanks to the inboard main tanks. To transfer fuel into the outboard main tanks it is necessary to use the crossfeed line. Bomb bay tanks feed into the common manifold (crossfeed) by means of a transfer pump and a selector valve located on the catwalk at Station 5.0.

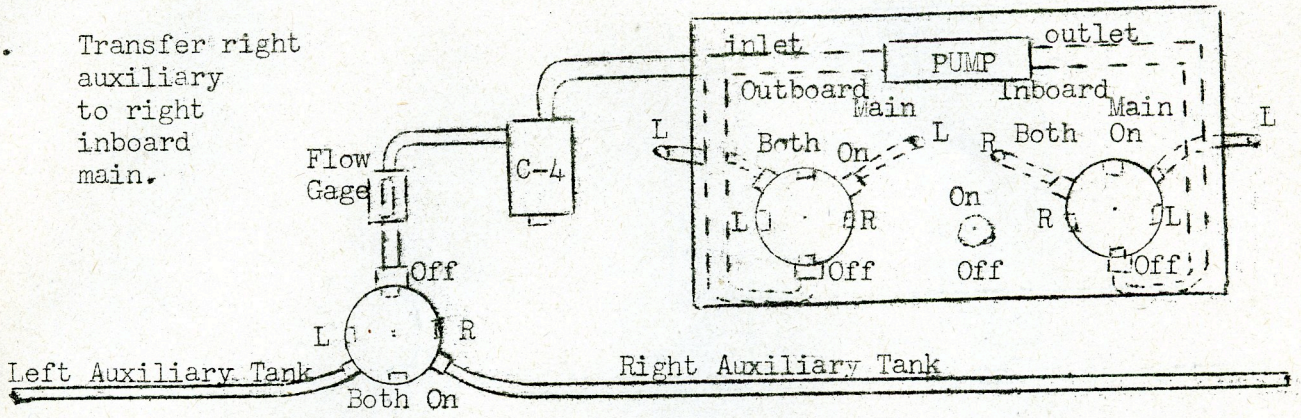
Example: Transfer fuel from the left wing auxiliary to the right inboard tank.



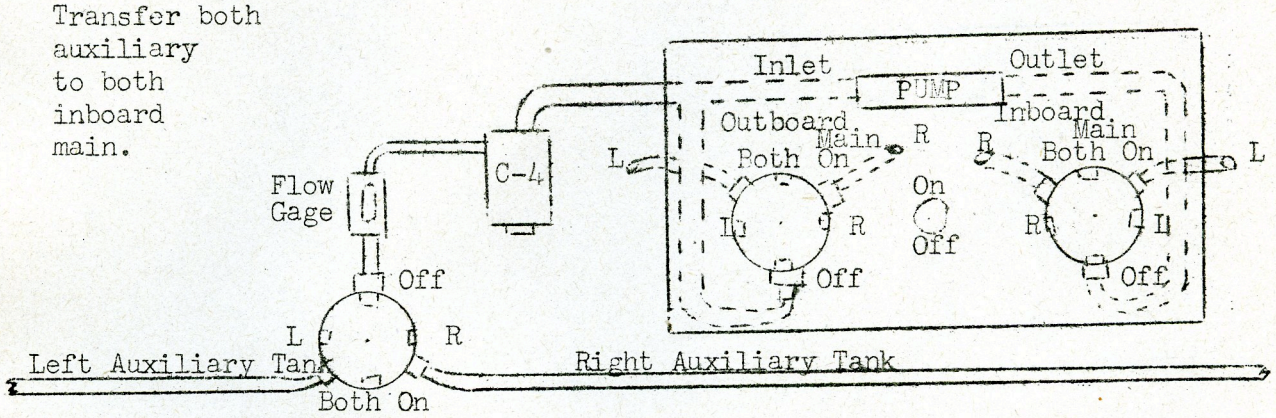
1. Transfer right inboard fuel to left inboard tank.



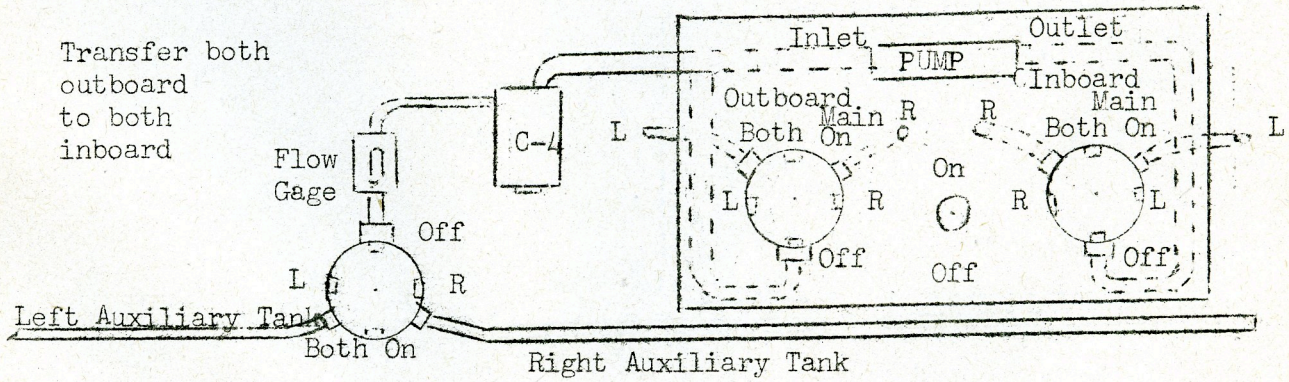
2. Transfer right auxiliary to right inboard main.



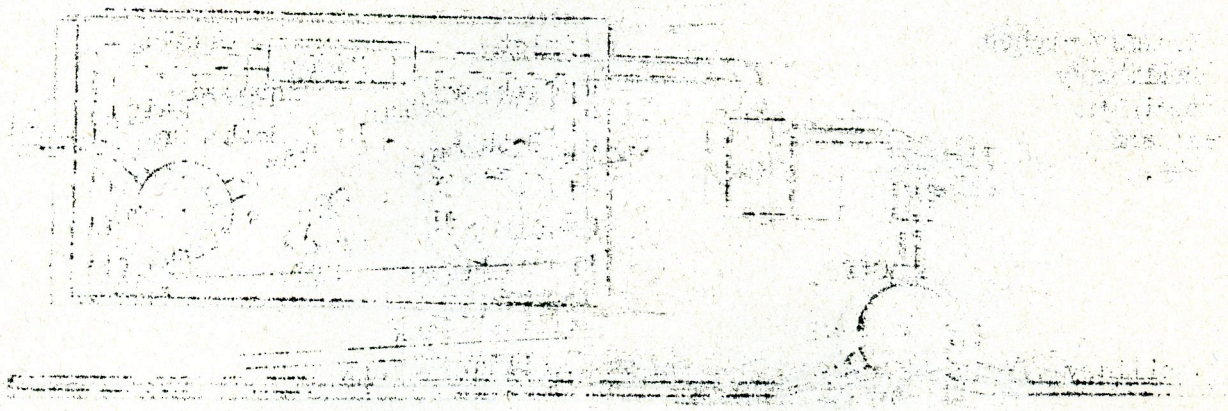
3. Transfer both auxiliary to both inboard main.

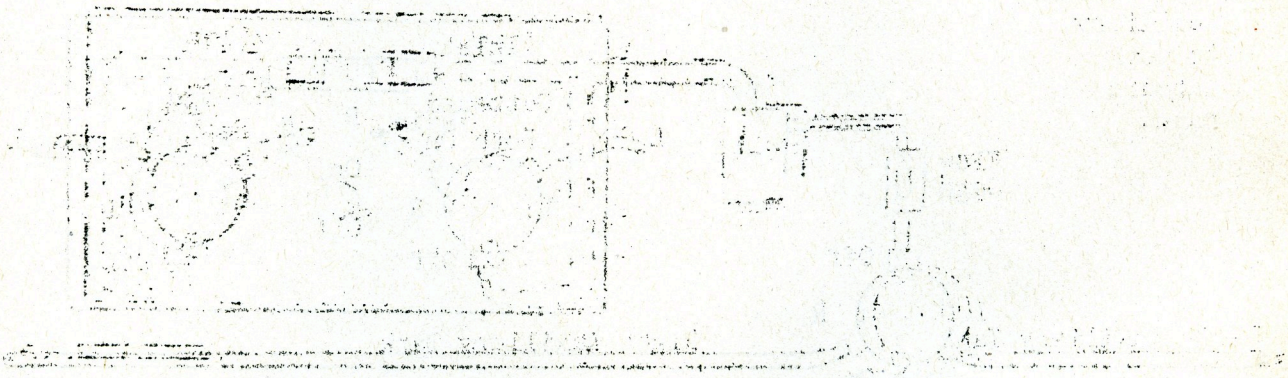


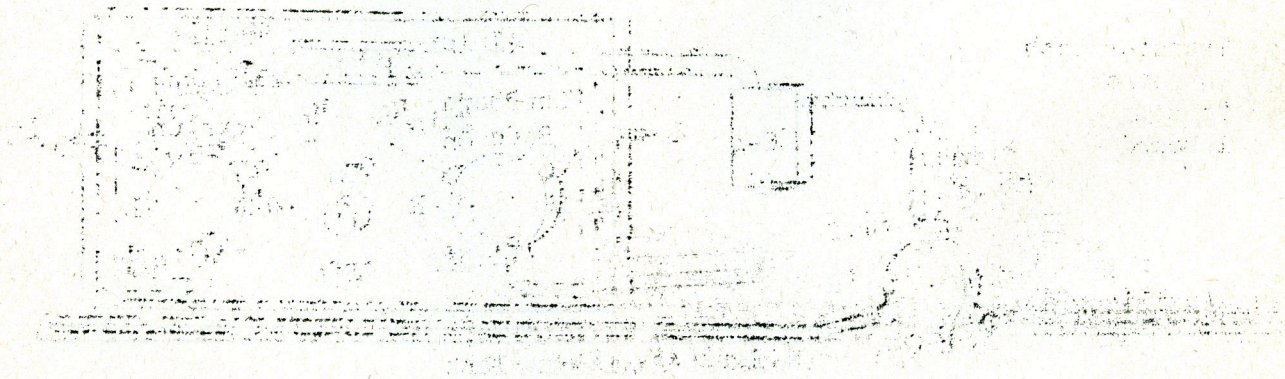
4. Transfer both outboard to both inboard



5. Using the schematic of this transfer system as a problem answer sheet, transfer fuel from the right outboard to the left inboard using the transfer panel and the crossfeed simultaneously. (See next page for schematic).







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SUMMARY QUESTIONS - II

1. Is it possible to transfer fuel from inboard cells to outboard main cells by this system? Explain how?

2. How is fuel transferred from the bomb bay tanks to the main tanks in this system?

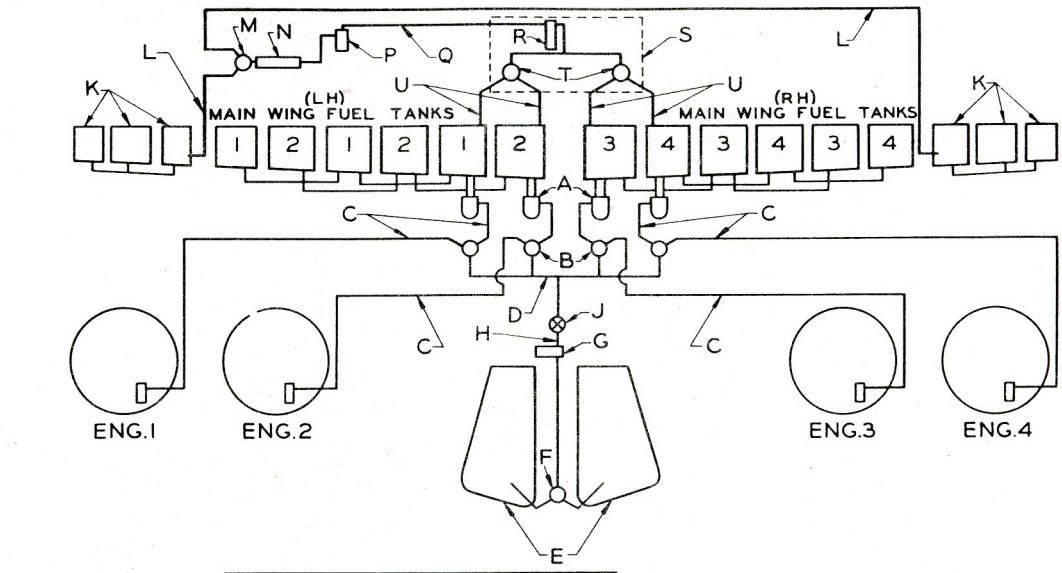
3. What would happen if you failed to turn the wing auxiliary selector valve to the "off" position when transferring fuel from the outboard main cells to the inboard main cells?

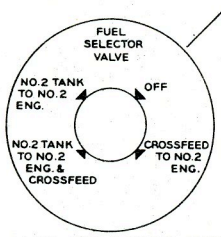
4. Is there any interconnecting line between the auxiliary transfer system on top of the center wing section and the cross-feed manifold?

5. Where is the switch for the pump located? Can it be controlled from the flight deck?

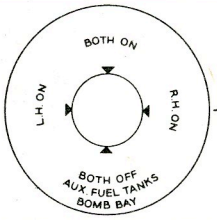
FUEL FLOW DIAGRAM

FOR B-24G AND B-24J AIRPLANES

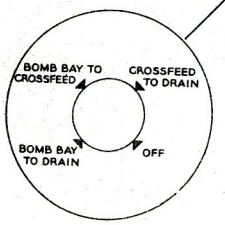




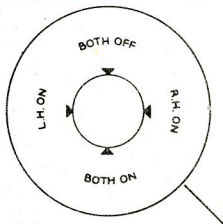
MAIN SELECTOR VALVE



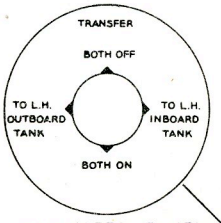
BOMB BAY SELECTOR



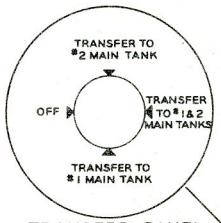
BOMB BAY SHUT-OFF



AUXILIARY WING TANK



TRANSFER PANEL ON B-24G



TRANSFER PANEL ON B-24J

A - MAIN WING TANK BOOSTER PUMPS
B - MAIN WING TANK SELECTOR VALVES
C - BASIC FUEL LINES
D - CROSSFEED MANIFOLD
E - BOMB BAY TANKS
F - BOMB BAY TANK SELECTOR VALVE
G - BOMB BAY TANK BOOSTER PUMP
H - BOMB BAY TO CROSSFEED FUEL LINE
J - BOMB BAY SHUT-OFF VALVE
K - AUXILIARY WING FUEL CELLS
L - AUXILIARY WING TANK FUEL LINES
M - AUXILIARY WING TANK SELECTOR VALVE
N - AUXILIARY WING TANK VISUAL FLOW INDICATOR
P - AUXILIARY WING TANK FUEL STRAINER
Q - FUEL LINE FROM STRAINER TO TRANSFER PUMP
R - FUEL TRANSFER PUMP
S - FUEL TRANSFER UNIT
T - TRANSFER UNIT TRANSFER VALVES
U - TRANSFER FUEL LINES

Fuel Flow Diagram—B-24G and J Airplanes

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FUEL TRANSFER PROBLEMS III
(IN FLIGHT)

Type III - B-24J (Consolidated) Selector Valve Panel Transfer System:

This transfer unit is very similar to the Selector Valve Panel Transfer System on the Ford built B-24E. In this system it is possible, however, to transfer fuel from the auxiliary wing tanks to either inboard or outboard main tanks, whereas on the B-24E it was possible to transfer only to inboard tanks.

Use the Consolidated B-24J Fuel System Mock-up to perform the operations listed below.

1. Transfer fuel from the left wing auxiliary tank to No. 3 main tank.

2. Transfer fuel from the right bomb bay tank to No. 1 main tank.

3. Transfer fuel from the No. 4 main tank to No. 2 main tank.

SUMMARY QUESTIONS III

1. On this model airplane, can fuel from both auxiliary wing tanks be transferred to all main tanks in a single operation?

2. During flight how many main tanks should be filled from the bomb bay tanks during one single transfer operation?

3. What is the difference between this system and that of the late B-24E?

4. What is the purpose of the bomb bay shut-off valve on the bomb bay transfer line, next to the crossfeed?

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FUEL TRANSFER PROBLEMS IV
(IN FLIGHT)

Type IV - B-24H: Centralized Selector Valve System:

In this system all main tank and auxiliary wing tank selector valves are on a common panel located just to the left of the fuel sight gages at Station 4.1. This system is also used on the B-24J built by Ford.
NOTE: The problems stated below can be worked out on the schematic which represents this B-24H Centralized fuel selector valve system. There is a separate schematic for each problem. Draw arrows to indicate the setting of selector valves. (Schematics are on the following pages.)

1. Show on the schematic how fuel in the B-24H may be transferred from the right inboard tank to the right outboard tank. Assume that the ship is flying at an altitude of 8000 feet.

2. If the ship is flying at an altitude of 9000 feet, show the settings of all selector valves when transferring fuel from the left auxiliary wing tank to No. 3 main tank.

3. When flying at 15000 feet indicate the proper selector valve settings for transferring fuel from the right bomb bay tank to No. 1 main tank.

4. When flying at 12000 feet indicate the proper selector valve settings for transferring fuel from the left outboard tank to the left inboard tank.

5. Inspect the B-24H fuel transfer system according to instructions outlined in the Red Line T.O. 01-5E-54. (This inspection is to be performed with the ship on the ground.)

WAR DEPARTMENT
HEADQUARTERS OF THE ARMY AIR FORCES
WASHINGTON

TECHNICAL ORDER
No. 01-5E-54

DIST: 2.4
FILE: BEHS

October 30, 1943

AIRPLANE AND MAINTENANCE PARTS

CONSOLIDATED - INSPECTION OF FUEL TRANSFER SYSTEM - B-24H

This Technical Order replaces T.O. No. 01-5E-54, dated October 16, 1943, revised to specify all engines will be running during the inspection.

NOTE: The publication of this Technical Order has been expedited as the instructions contained herein are of vital importance and should be disseminated to all affected personnel without delay. The provisions of T.O. No. 00-20A will be complied with in this case, these instructions being entered on AAF Forms 60-A for the airplanes affected. The work directed herein will be accomplished as soon as possible and not later than the next 25-hour inspection period by service activities with the aid of sub-depots, if necessary.

1. To eliminate the possibility of engine failure, improper fuel transfer, and possible fire hazard as a result of improper fuel hose connections at fuel system accessories, B-24H airplanes, AF Nos. 42-7465 to 42-7770 inclusive and 42-52077 to 42-52111 inclusive and will be inspected and corrected, if necessary, in accordance with the instructions contained in paragraph 2. B-24H airplanes, AF No. 42-52112 and subsequent, will be inspected prior to delivery.

2. The instructions for accomplishing this inspection are as follows:

a. The procedures outlined in paragraph 2.b. will be accomplished with all engines running.

NOTE: These tests will be accomplished during regular pre-flight or other run-up times in order to avoid unnecessary ground engine run-up.

b. (1) With auxiliary tank selector valve in the "BOTH ON" position, fuel selector valve for engine No. 1 in "ENGINE TO CROSSFEED" position, engine No. 1 booster pump "OFF", and bomb bay catwalk booster pump "ON", engine No. 1 must be operable. Turn off the bomb bay catwalk booster pump and set the auxiliary fuel tank selector valve in "BOTH OFF" position after this test.

(2) With engine No. 1 fuel selector valve in "TANK TO ENGINE" position and engine No. 1 booster pump "ON", engine No. 1 must be operable.

(3) With engine No. 1 booster pump "ON" and No. 1 selector valve to "ENGINE TANK AND CROSSFEED" the following conditions must be satisfied;

(a) With engine No. 2 fuel selector valve in both "TANK TO ENGINE" position and "CROSSFEED TO ENGINE" position, engine No. 2 must be operable.

(b) With engine No. 3 fuel selector valve in both "TANK TO ENGINE" position and "CROSSFEED TO ENGINE" position, engine No. 3 must be operable.

(c) With engine No. 4 fuel selector valve in both "TANK TO ENGINE" position and "CROSSFEED TO ENGINE" position, engine No. 4 must be operable.

c. If a particular engine fails to operate under the conditions as outlined in paragraph 2.b., inspect the fuel hose connections at its selector valve located on the centralized fuel panel, flight compartment, and change the hose connections as necessary. Correct connections should be as follows:

(1) With the selector valve in the "TANK TO ENGINE" position, the poppet of the selector valve port which is connected to the fuel booster pump, should be open.

(2) With the selector valve in the "CROSSFEED TO ENGINE" position, the poppet of the selector valve port, which is connected to the crossfeed manifold line, should be open.

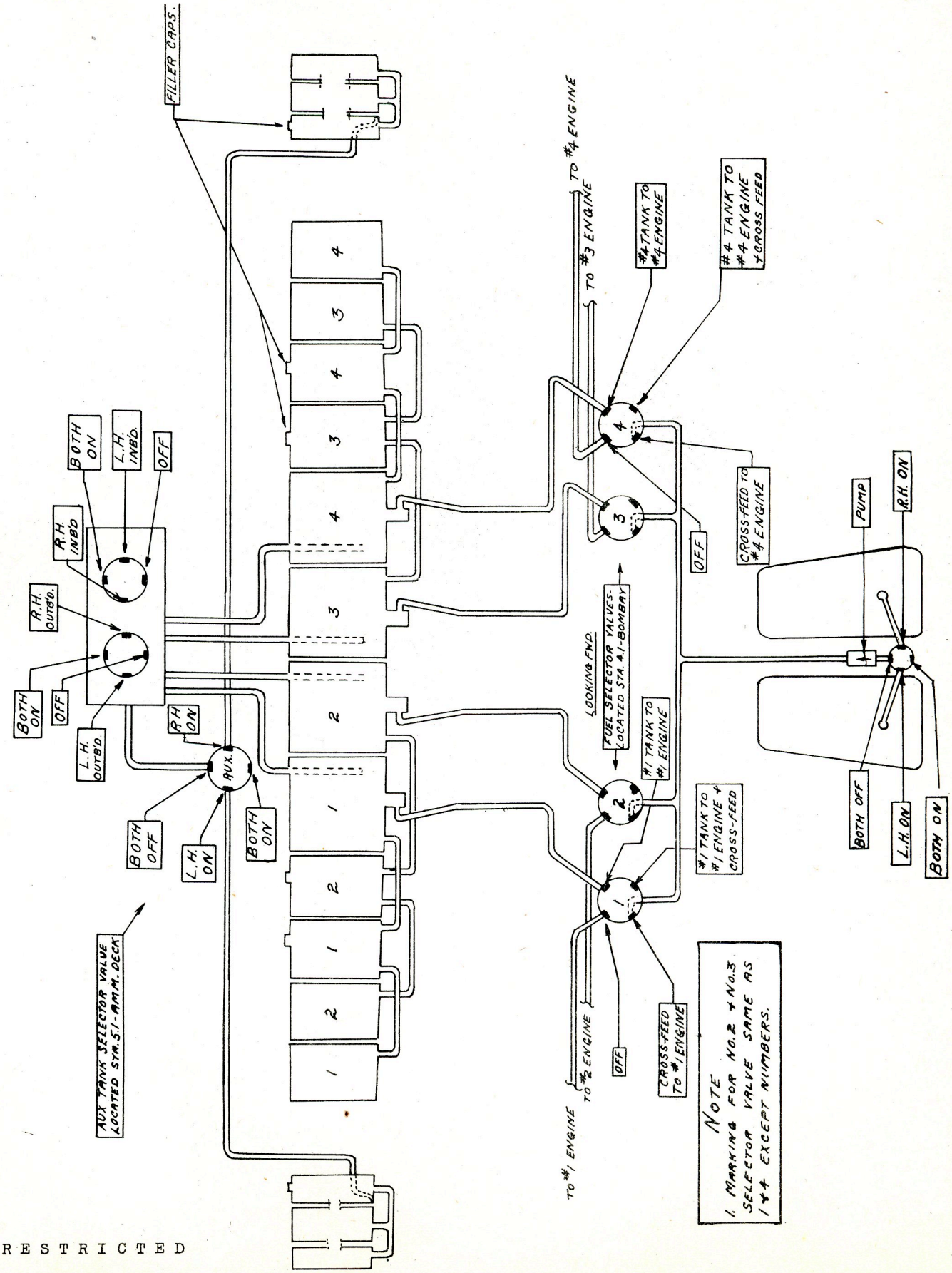
(3) With the selector valve in the "TANK, ENGINE AND CROSSFEED" position, both poppets of the selector should be open.

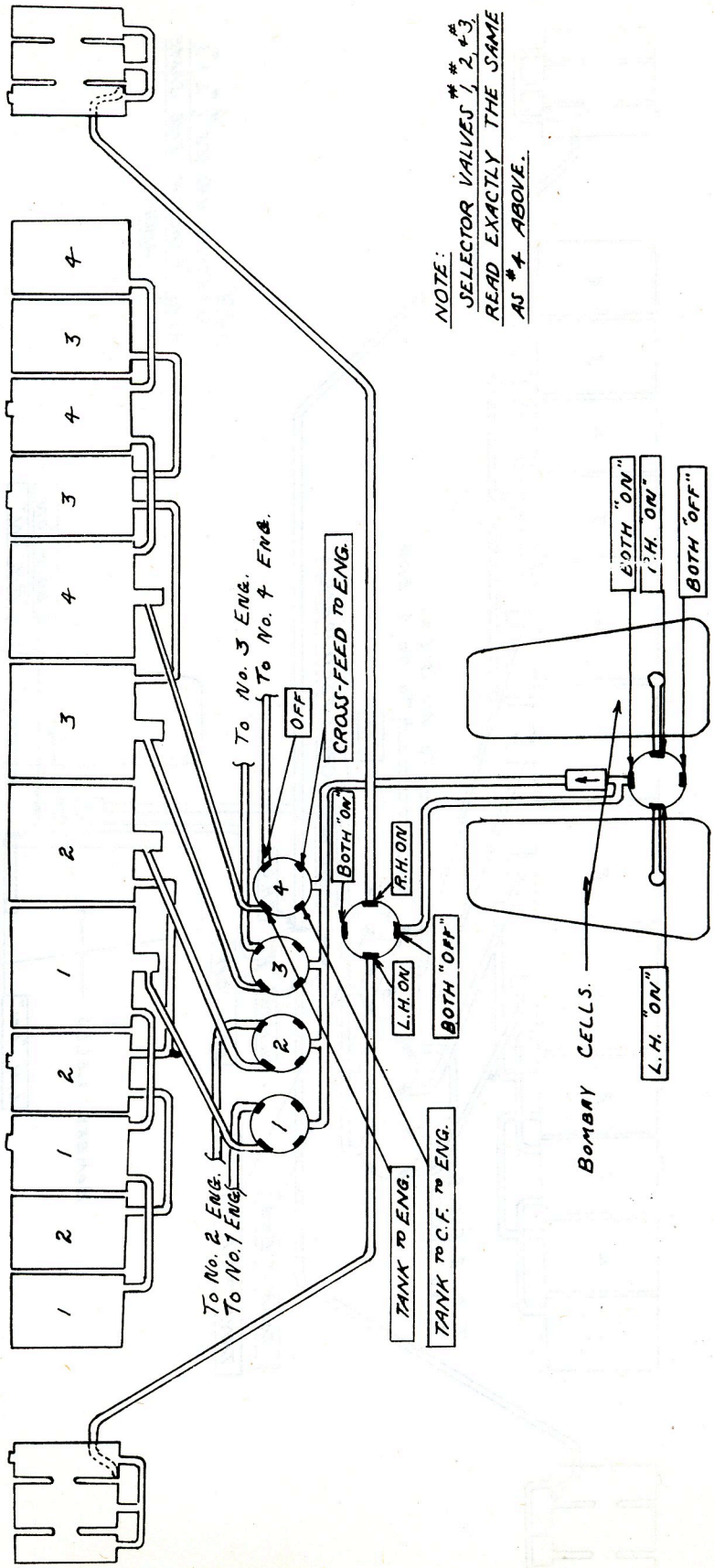
(4) With the selector valve in the "OFF" position, both poppets of the selector valve should be closed.

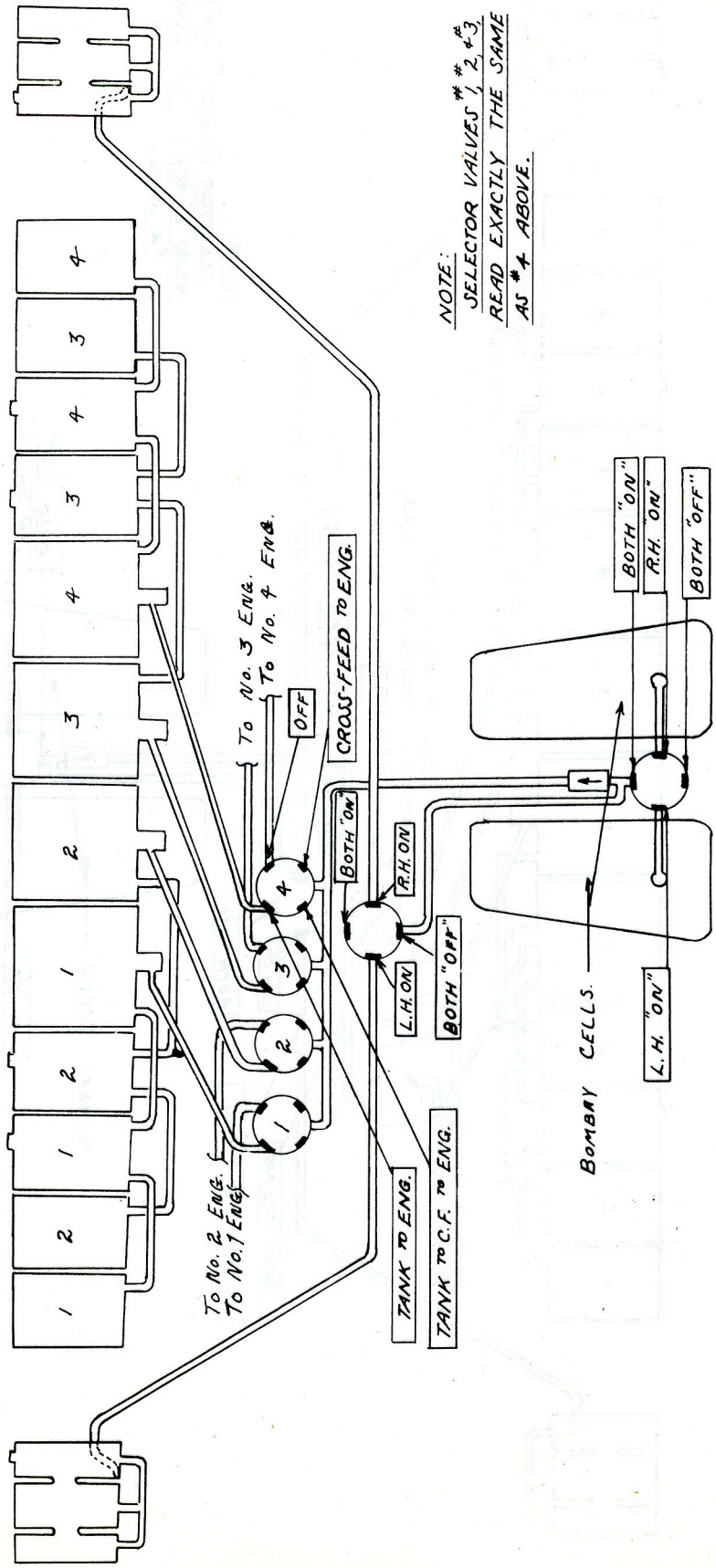
d. If the auxiliary fuel transfer system does not operate correctly when inspection is made in accordance with paragraph 2.b. (1), further inspect the fuel hose connection at the bomb bay catwalk booster pump for correct inlet and outlet connections, and at the fuel transfer panel. The pressure side of the bomb bay booster pump should be connected to the crossfeed manifold and the suction side to the auxiliary tank selector valve. Change if necessary.

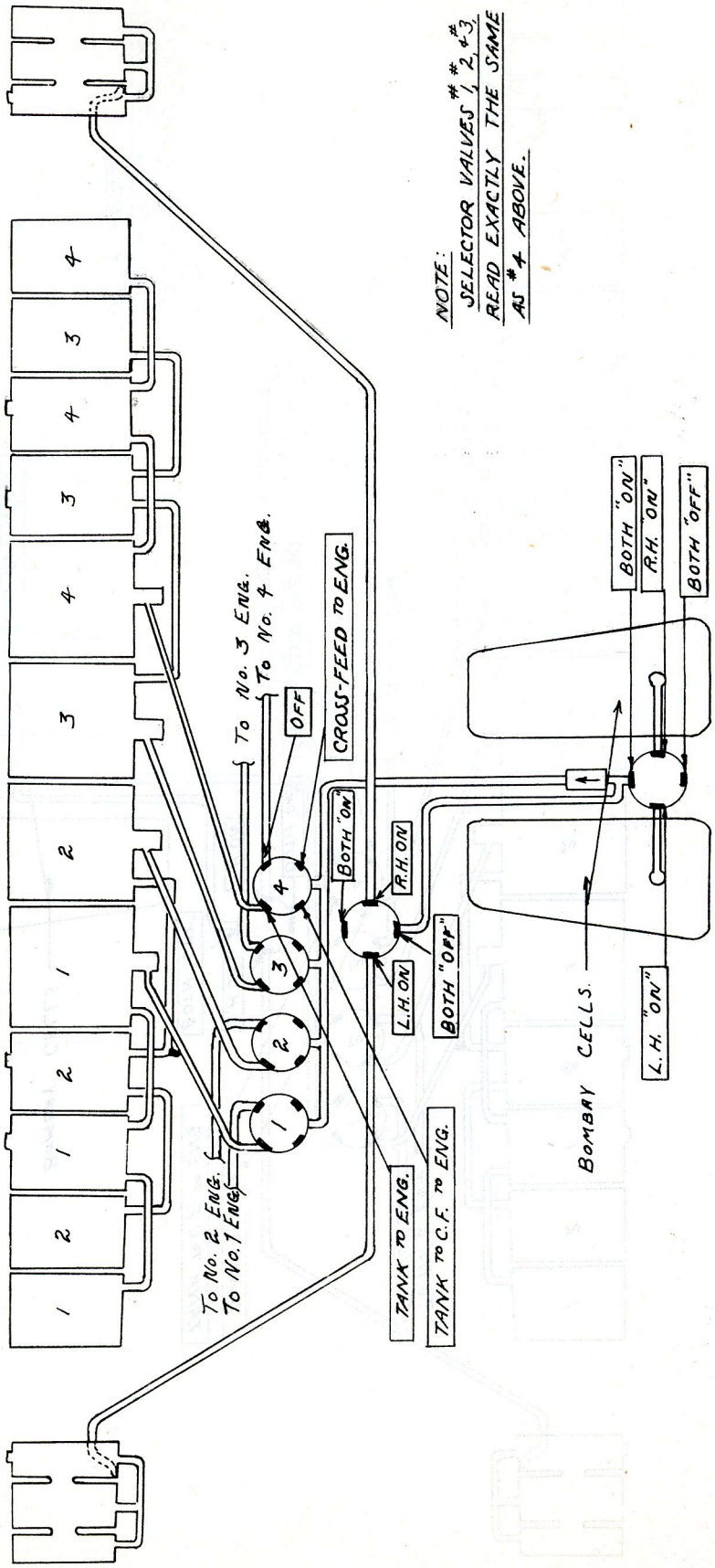
By Command of General ARNOLD;

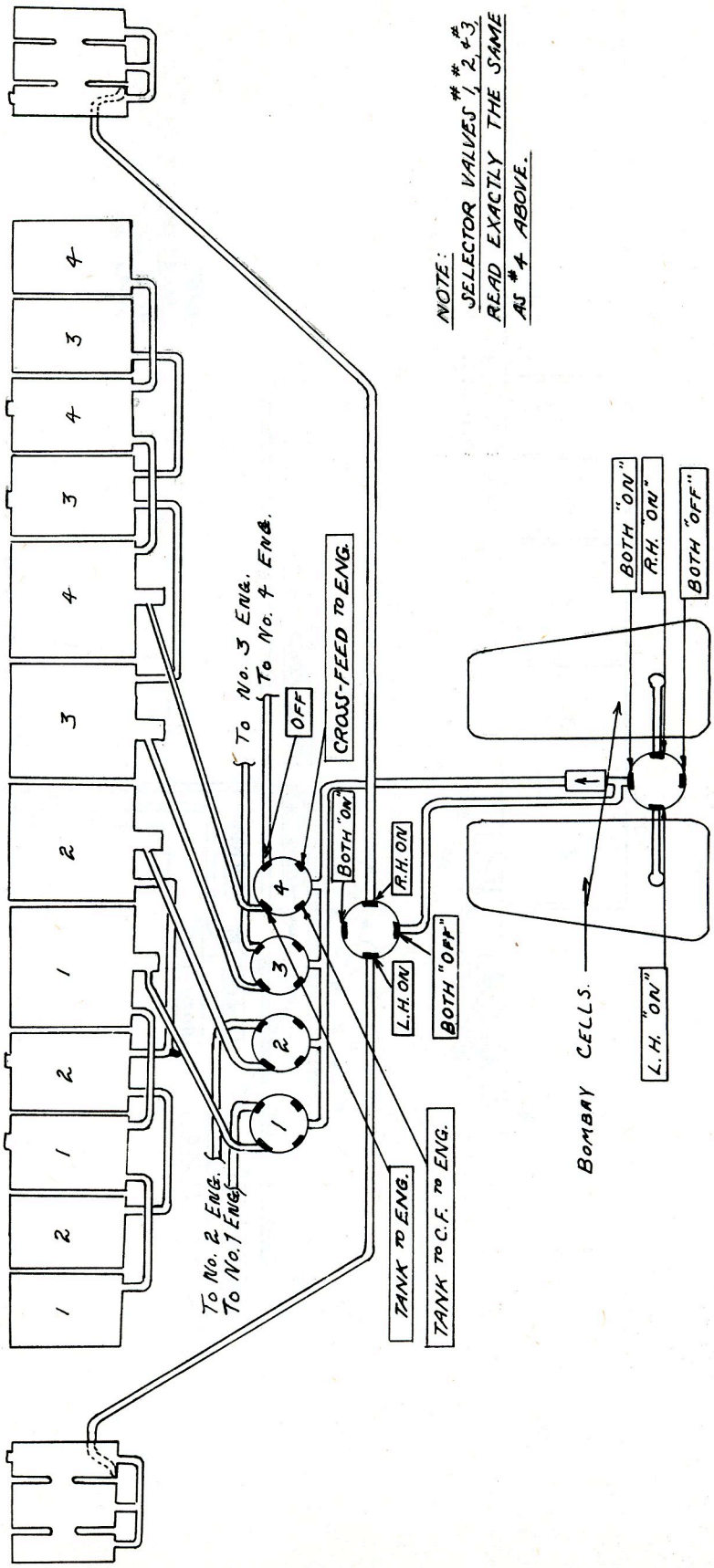
WALTER H. FRANK,
Major General U.S.Q.,
Commanding General, Air Service Command.


FILLER CAPS.
TO #4 ENGINE
TO #3 ENGINE
#4 TANK TO #4 ENGINE
#4 TANK TO #4 ENGINE + CROSS FEED
BOTH ON
L.H. INBD.
OFF
R.H. INBD
R.H. OUTBD.
BOTH ON
OFF
L.H. OUTBD.
RH ON
AUX.
BOTH OFF
L.H. ON
BOTH ON
AUX TANK SELECTOR VALVE LOCATED STA. 51 - AMM. DECK
LOOKING FWD.
FUEL SELECTOR VALVES LOCATED STA. 41 - BOMBAY
#1 TANK TO #1 ENGINE
#1 TANK TO #1 ENGINE + CROSS-FEED
CROSS-FEED TO #4 ENGINE
OFF
PUMP
R.H. ON
BOTH OFF
L.H. ON
BOTH ON
TO #1 ENGINE
TO #2 ENGINE
OFF
CROSS-FEED TO #1 ENGINE
NOTE
1. MARKING FOR NO. 2 + NO. 3 SELECTOR VALVE SAME AS 1 + 4 EXCEPT NUMBERS.


NOTE:
SELECTOR VALVES #1, #2, & #3
READ EXACTLY THE SAME
AS #4 ABOVE.
1
2
3
4
TO NO. 2 ENG.
TO NO. 1 ENG.
TANK TO ENG.
TANK TO C.F. TO ENG.
L.H. ON
BOTH "OFF"
R.H. ON
BOTH "ON"
CROSS-FEED TO ENG.
OFF
TO NO. 3 ENG.
TO NO. 4 ENG.
BOMBAY CELLS.
L.H. "ON"
BOTH "ON"
R.H. ON
BOTH "OFF"


NOTE:
SELECTOR VALVES #1, #2 & #3
READ EXACTLY THE SAME
AS #4 ABOVE.
BOTH "ON"
R.H. "ON"
BOTH "OFF"
L.H. "ON"
BOMBAY CELLS.
TO No. 3 ENG.
TO No. 4 ENG.
OFF
CROSS-FEED TO ENG.
BOTH "ON"
R.H. ON
L.H. ON
BOTH "OFF"
TANK TO ENG.
TANK TO C.F. TO ENG.
TO No. 2 ENG.
TO No. 1 ENG.
1
2
3
4


NOTE:
SELECTOR VALVES #1, 2, & 3
READ EXACTLY THE SAME
AS #4 ABOVE.
BOTH "ON"
R.H. "ON"
BOTH "OFF"
L.H. "ON"
BOMBAY CELLS.
TO No. 3 ENG.
TO No. 4 ENG.
OFF
CROSS-FEED TO ENG.
BOTH "ON"
R.H. ON
L.H. ON
BOTH "OFF"
TANK TO ENG.
TANK TO C.F. TO ENG.
TO No. 2 ENG.
TO No. 1 ENG.


NOTE:
SELECTOR VALVES #1, #2 & #3
READ EXACTLY THE SAME
AS #4 ABOVE.
BOTH "ON"
R.H. "ON"
BOTH "OFF"
L.H. "ON"
BOMBAY CELLS.
CROSS-FEED TO ENG.
OFF
TO No. 3 ENG.
TO No. 4 ENG.
BOTH "ON"
R.H. ON
L.H. ON
BOTH "OFF"
TANK TO ENG.
TANK TO C.F. TO ENG.
TO No. 2 ENG.
TO No. 1 ENG.
1
2
3
4

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FORD AIRPLANE SCHOOL

SUMMARY QUESTIONS IV

1. Why was the transfer system above the wing abandoned?

2. Is it a good plan to "take-off" with the selector valves all set to Tank, Engine, and Cross-feed? Explain.

3. Why should fuel transfer from auxiliary cells be delayed until the ship has gained appreciable altitude?

4. Should a booster pump be operating on a tank that is to receive fuel from the cross-feed transfer system?

5. What is the best method of draining the tanks of the B-24? Explain carefully in full detail.

6. Is it possible for fuel to drain from the main tanks or auxiliary wing tanks into the bomb bay tanks? If so, what can be done to prevent this?

7. Is it possible to operate an engine with fuel coming direct from the bomb bay or wing auxiliary tanks?

RESTRICTED

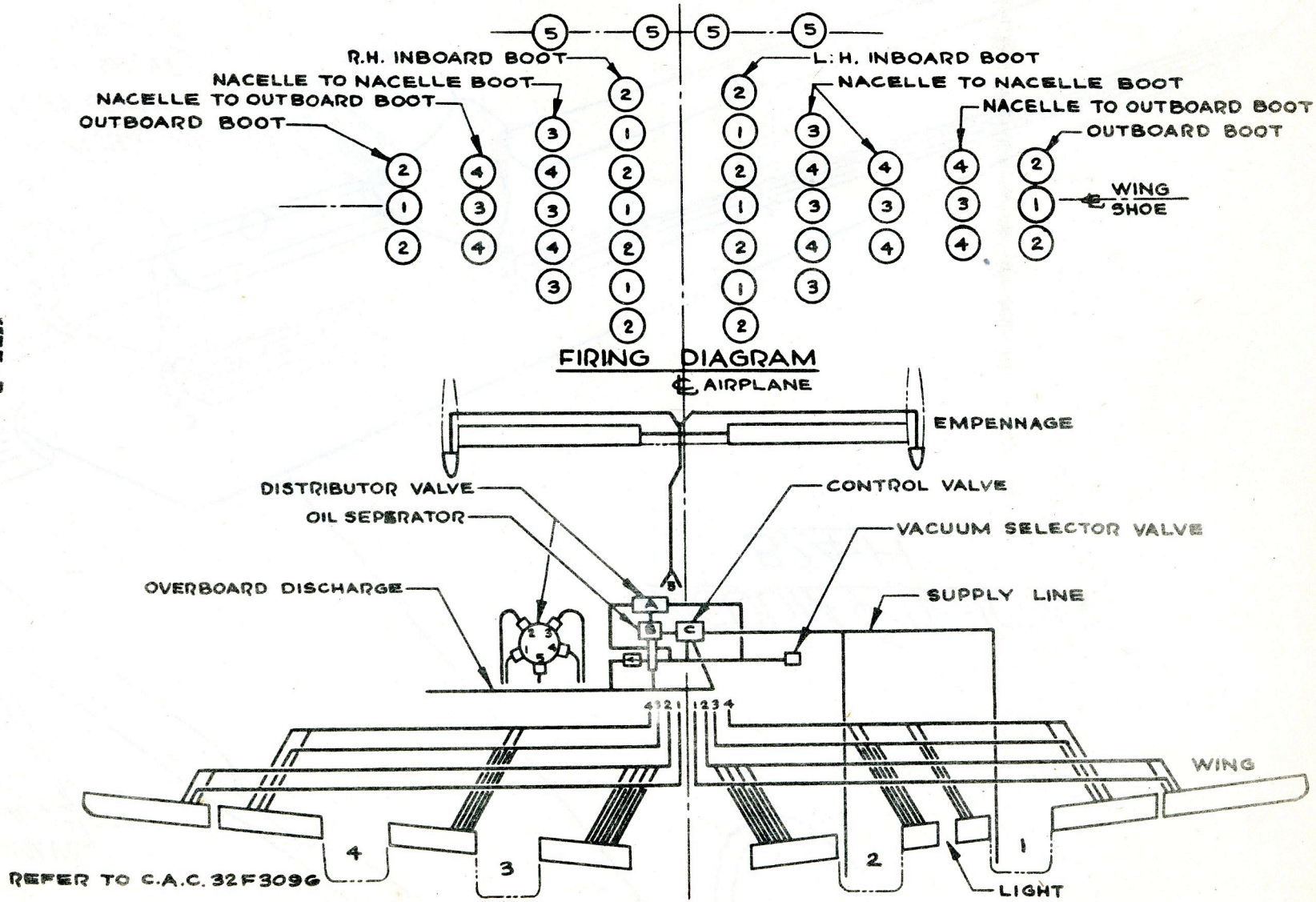

FIGURE 1
DE-ICER SYSTEM DIAGRAM

REVISED 11-1-41.

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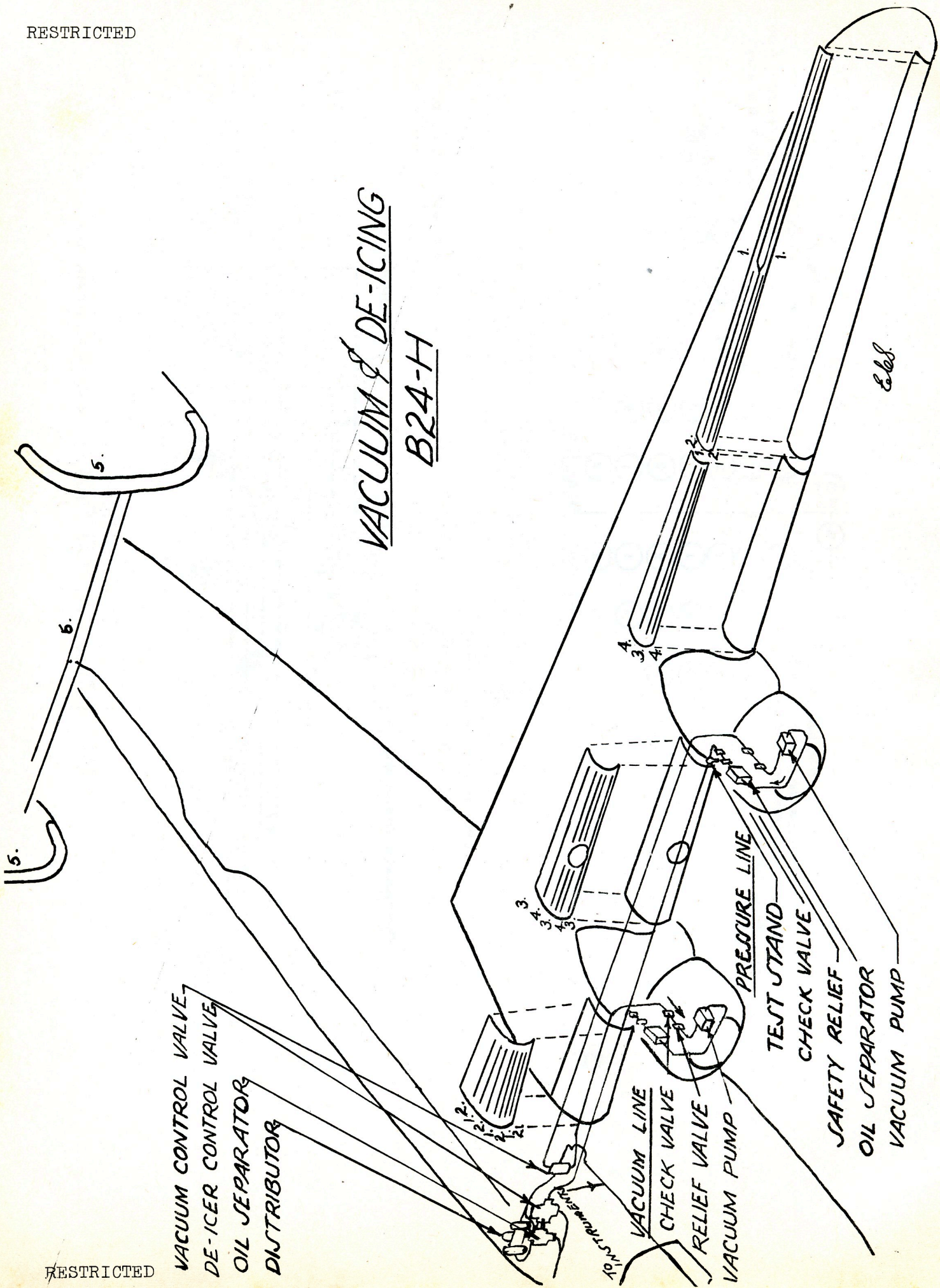
VACUUM & DE-ICING
B24-H
VACUUM CONTROL VALVE
DE-ICER CONTROL VALVE
OIL SEPARATOR
DISTRIBUTOR
VACUUM LINE
CHECK VALVE
RELIEF VALVE
VACUUM PUMP
PRESSURE LINE
TEST STAND
CHECK VALVE
SAFETY RELIEF
OIL SEPARATOR
VACUUM PUMP

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DE-ICER SYSTEM OPERATION AND INSPECTION

UNIT TECH ORDER REF.	INFORMATION	INSPECTIONS
Vacuum-Pressure Pump Type: Pesco-B-8 vane type 1. 03-1-6 General Repair 2. 03-30AA-1 Section IV	1. Develops both vacuum and pressure. 2. Located on engines #1 and #2. 3. Oiled through one of four holes in mounting flange. 4. Note the direction of rotation. 5. By arrow on housing, determine suction and pressure port. 6. Mount the pump for ease of hose connections 7. Freedom of operation tested by turning with hand. 8. Examine engine mounting pad for lubrication holes. 9. Align oil holes of pump, gasket and engine mounting pad. 10. Turn gasket to block engine lubrication if an outside source of oil is used. 11. Test pressure side of pump with paper for oil delivery. Oil must be present.	Daily: Check vacuum for 4" Hg. Check the operation of each pump by changing selector valve. 50 Hr: Same as daily. 100 Hr: Check for security of mounting. Engine Change: remove and clean pump.
Oil Separator Type: Pesco B-8 T.O. 03-30AA-1	1. There are two Pesco Oil Separators: one on engine #1 and one on #2. 2. There are no movable parts. A perforated baffle plate removes oil from the air. 3. The oil returns through a restriction in the drain to the engine accessory. 4. The separator is mounted at a 20° angle.	100 Hr: Separators having removable screens over the oil drain must have them cleaned. Inspect separator for security of mounting.
Safety Valve. Pesco: Model 3V-217-h Type B-8 T.O. 03-30AA-1, Section IX	1. The safety valve is a spring-loaded, disc type contained in an aluminum housing. 2. Purpose: It relieves excess pressure. The pump is operated at 3750 R.P.M. and 4" Hg. vacuum. The valve unseats at 24" Hg. maximum, but ranges in operation from 15" to 19" Hg. 3. Pressure adjustment may be made by adding or removing spacer washers around the valve guide.	100 Hr: Remove and clean the valve guide. Dress valve on an oil stone, if worn. Check the spring tension.

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

DE-ICER SYSTEM OPERATION AND INSPECTION

UNIT AND TECH ORDER REF.	INFORMATION	INSPECTION
	4. Check the spring tension by compressing it to 1½" length. The force required is 3.7# minimum. 5. Safety Valve prevents overheating of the pump in case of back pressure. There is one for each pump. 6. The Safety Valve is installed after the oil separator---by means of hose and pipe connections.	
Check Valve Type: Pesco-Model 226 T.O. 01-5EC-2	1. Three Check Valves are found in the system: one on the pressure side of each pump, and one between the overboard line and the vacuum selector valve line. 2. It is the spring-loaded disc type. 3. Purpose: A. Valve prevents air pressure from entering the pump in case of pump failure of one engine, or when using the test connection inboard #1 engine. 4. Installed with the indicating arrow on the housing pointing away from pump. Dress the disc on an oil stone, if rough.	100 Hr: None Engine Overhaul Period: Examine for seating and wear. Replace badly worn discs.
Control Valve. Eclipse: Type 577-Model 2. Style A. T.O. 01-5EC-2 03-35B-4 AN 01-5EF-4 Fig. 160 T.O. 03-1-6	1. Purpose: When "on", it ---- a. Directs the pressure from the pumps to the distributor for inflating the boots. b. Makes electrical connection, thus turning "on" the motor which operates the distributor. When "off": a. Air pressure is directed overboard back of No. 3 engine. b. The last inflated cells are deflated by connecting them to the vacuum selector valve. 2. The de-icer control valve has a. A lower housing with 3 ports: 1 marked "pump"; 1 marked "de-icer", and one in the base marked "outlet".	Major overhaul period: Remove the units and send to an authorized service station.

DE-ICER SYSTEM OPERATION AND INSPECTION

UNIT TECH ORDER REF.	INFORMATION	INSPECTION
	b. A 4-way valve with an integrally mounted shaft for control and an electrical switch. When "on", one port leads straight through. When "off", one port leads to "outlet"; one port (de-icer) connects to the de-icer vent and the vacuum. c. The upper housing which consists of (1) a wiring contact to operate the distributor motor and (2) a de-icer vent port.	
Eclipse Oil Separator T.O. 03-1-6 AN-01-5EF-4 Illus. Fig. 161 p. 319	1. The Eclipse oil separator has 2 functions: a. It removes oil from pump air and cleans the air from an outside test connection. b. It controls the air pressure entering the boots. 2. The separator consists of an aluminum housing. From the top is suspended a cylinder in which are copper turnings. Oil is removed when passing through this. 3. An adjustable pressure relief valve is located in the lower part of the outer housing. Pressure setting is 8 p.s.i. Excess air and oil moves overboard outboard of engine #3	Major overhaul Period (Depot): 1. Dissemble and clean in carbon-tetrachloride. 2. Dress relief valve if worn or scarred. 3. Replace the housing gasket at every overhaul. Coat gasket with approved sealant. 4. Test after reassembling by plugging the outlet at the top with a pipe plug; Remove the 1/8" pipe plug and insert a pressure gage. Adjust the pressure relief to 7½"-8 p.s.i. NOTE: Use sealing compound on all pipe fittings.
Distributor Valve Type 574 Model 2, Style A. T.O. 03-35B-4 03-1-6 Chap. 51A 01-5EF-4 Parts List Illus., Fig. 160	1. The valve consists of a rotary distributor valve housing on opposite ends of a gear housing, 2 rotary valves, the reduction gearing, and a driving motor. 2. Each rotary valve housing incorporates; (a) five 3/4" ports equally spaced in a perpendicular plane to the center	50 Hr: Check brushes for 13/32" minimum.

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

DE-ICER SYSTEM OPERATION AND INSPECTION

UNITS AND TECH ORDER REF.	INFORMATION	INSPECTIONS
	line of the rotary valves, and (b) one 3/4" port called a "Vent-line" which is attached to the vacuum selector valve. 3. The gear housing incorporates in the bottom a 1" pipe thread port. ("Inlet Vent") which permits air from the control valve and oil separator to flow to each rotary valve. 4. The rotary valve distributes air, with the proper timing, to each de-icer cell. 5. The rotary valves are driven by a motor mounted above the gear housing. Gear reduction times each revolution to about 40 seconds. 6. At the outer end of each rotary valve housing is a vent line. These combine at the left of the valves, and a single line enters the vacuum selector valve. Also entering this line is one from the de-icer control vent-line which deflates the cells last under pressure.	
De-Icer Boots T.O. 01-5EC-2 Sect. IV	1. There are 4 boots on each wing: (a) outboard; (b) nacelle to O.B. (c) nacelle to nacelle boots; and (d) inboard boot. 2. Each boot has one or more longitudinal cells: 3. Air pressure from pumps on engines #1 and #2 inflate the boots. 4. The boots are deflated by connecting them to the vacuum side of the pump through the 4-way vacuum selector valve. 5. Pressure from the rotary valve enters one of 4 horizontal de-icer assembly tubes, thence to definite cells. A manifold distributes air to those cells that are inflated simultaneously.	Maintenance: 1. Consists of patching and recoating the surface. 2. Testing of shoes will be a visual examination of surface for cuts, tears, and damaged spots. Also test for surface conductivity.

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DE-ICER SYSTEM OPERATION AND INSPECTION

UNIT AND TECH ORDER REF.	INFORMATION	INSPECTIONS
Vacuum Four-Way Valve T.O. 01-5EC-2 Section IV	1. The vacuum 4-way valve is a hand operated cone-type valve. 2. By it, either pump may operate the vacuum instruments; simultaneously the de-icer is operated by the other engine pump.	Servicing: No particular servicing is necessary. A hand operating valve may be cleaned and re-lubricated with light oil.
Air Filters T.O. 05-1-34 T.O. 01-5EC-2 Type: Purolator Products Spec. No. A.N.-5822-1 Type Pa-12	1. The exterior consists of a flat cylindrical housing with a removable cover. The 3/4" air inlet is screened. From the outlet, clean air goes to the vacuum instruments. 2. The interior consists of 8 hollow porous discsstacked on top of one another. Air is cleaned by passing through the material. 3. The inlet shall be installed face downward to drain off any condensed water vapor.	25 Hr. Remove and clean the air inlet screen. Use a stiff bristled brush. 100 Hr: Under severe dust conditions test for a suction gage drop. If a 3.5" Hg. vacuum is found, refer to the 500 hour inspection. 500 Hr: See paragraph #2 in T.O. 05-1-35.
Skinner Products AN-F9 Air Filter (AC Spec. No. 27366) T.O. 05-1-35	1. This filter is in addition to those screens found within the instruments. 2. It is of the cleanable type. 3. It is rigidly mounted behind the instrument panel, and it is accessible from the bombardiers compartment. 4. The filter consists of (a) a filter bowl, (b) a filter cap, and (c) a cylindrically-tubed filter element. 5. Air is cleaned by tiny closely packed discs. 6. The filter may be cleaned by: (a) applying clean compressed air at the end of each element. However, do not apply air at right angles to the tiny filter discs. (b) a stiff bristle brush used to remove the loose dirt. (c) or the elements may be cleaned in gasoline or water under pressure. Dry it thoroughly before installing.	1. Frequency of cleaning of the intake screen and the air filter is dependent upon service conditions. 2. 500 Hr: This is the usual period for inspection. Depot inspections should determine if more frequent inspections are necessary.

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DE-ICER SYSTEM OPERATION AND INSPECTION

UNIT AND TECH ORDER REF.		INFORMATION		INSPECTIONS
Backfire Check valve (Weatherhead) T.O.01-5EC-2 Sect. IV	1.	An arrow on the valve indicates the direction of flow.	1.	Major over haul; Check the spring for tension and the seat and valve for proper closing. The latter may be lapped for proper seating.
	2.	Pressure in the vacuum line, due to engine reversal, is relieved by spring-controlled pop-up valve in the top of the housing.		
	3.	The check within the housing that prevents the return of air to the gyro instruments, should the engine reverse, is a spring hinged, flap type.		
Suction Relief Valve Type: Pesco B-8 T.O. 01-5EC-2	1.	The valve is a spring-loaded, disc-type.		
	2.	It is adjustable by means of a turnbolt. Turning it clockwise decreases the spring tension and thus the vacuum.		
	3.	Failure to function may be caused by dirt on the seat, scored spots, or loss of spring tension. If rough, the valve disc may be lapped down on an oilstone.		

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

DE-ICER SYSTEM PROBLEMS AND PROCEDURES

VACUUM PUMP

1. What type of pump is the vacuum pump?
2. Where would one look for the manufacturer's name and pump model number?
3. What 2 methods of lubrication may be used on this pump?
4. To which engines are the vacuum pumps attached?
5. How is the pump tested for freedom of action?
6. Before mounting the pump, what 2 things need to be determined?
7. By what test can one know if enough oil is reaching the vacuum pump?
8. When the pump is internally lubricated what holes should be aligned?
9. What is the purpose of the 1/8" pipe plug found near the mounting flange of the pump?
10. If the vacuum from the pump on engine #1 deflates the boots, what does that on engine #2 do?
11. How is the rotation of a mounted pump determined?
12. Give the color code for the de-icer pressure. Give that for the vacuum.

OIL SEPARATOR (IN NACELLE)

1. How is the oil used for lubrication of the pump returned to the oil system?
2. To what section of the engine does the oil return?
3. At what angle are the Pesco oil separators mounted? Give the reason.
4. Why must all oil be removed before entering the boots?

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

DE-ICER SYSTEM PROBLEMS & PROCEDURES

SAFETY VALVE (IN NACELLE)

1. Two purposes of the safety relief valve are
   a. To provide a release for excess _____
   b. To prevent the _____ from overheating.

2. The maximum pressure at which the safety valve may unseat is _____

CHECK VALVES AND TEST CONNECTION

1. Give the location of 3 check valves.
2. Give 2 purposes of the check valves.
3. Where is the attachment for testing the system with an outside source of air?

DE-ICER CONTROL VALVE

1. Name the 2 functions of the control valve when it is "on".
2. What happens to the air when the valve is in "off" position?
3. Where is the Control for the De-Icer System located?

OIL SEPARATOR AND DISTRIBUTOR VALVE

1. Give 2 functions of the Eclipse Oil Separator.
2. To what instrument is the pressure line from the oil separator connected?
3. What part of the distributor valve determines to which boots the air pressure from the pump will go?
4. Give the direction of rotation of the inboard rotating spool. Does the opposite one rotate in the same direction?
5. There are 4 tubes in each wing de-icer tube assembly:
   #1 is connected to which boots and cells?

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

DE-ICER SYSTEM PROBLEMS AND PROCEDURES

#2 is connected to which boots & Cells?
#3 is connected to which boots & Cells?
#4 is connected to which boots & Cells?

6. How many of the 10 distributor valve ports are under suction when the valve is on? When off?

7. How is the air from the de-icer boots removed?

8. Give the time for one complete cycle of the distributor valve.

9. How long is the deflation period of the de-icer boot on the empennage?

10. What should be the minimum length of the motor brushes? At what period are they checked?

VACUUM SELECTOR VALVE AND AIR FILTER:

1. Are de-icing boots deflated by the same vacuum pump that operates the instruments?

2. If the pump on engine #2 is deflating the boots, will one get the correct suction reading for the pump without resetting the Vacuum Selector Valve?

3. Give the names of 2 different types of air filters.

4. Describe briefly the shape of the housing and the filtering element of each.

5. In mounting the filter should the inlet be up or down?

BACKFIRE CHECK AND SUCTION RELIEF VALVES:

1. Give the location and the manner of installation of the backfire check valve.

2. What inspection is given at the 500 Hour?

3. What suction is maintained in the vacuum system?

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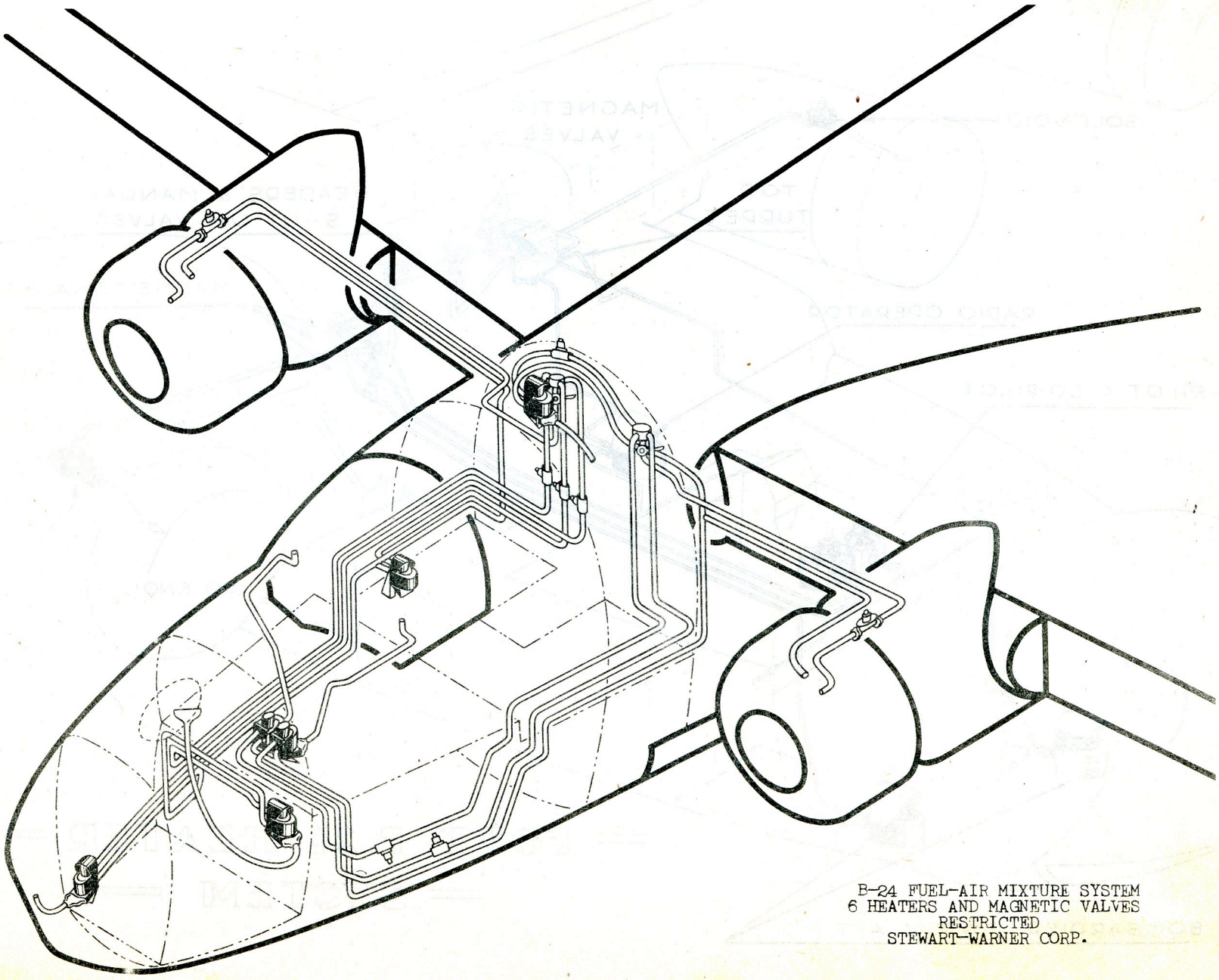
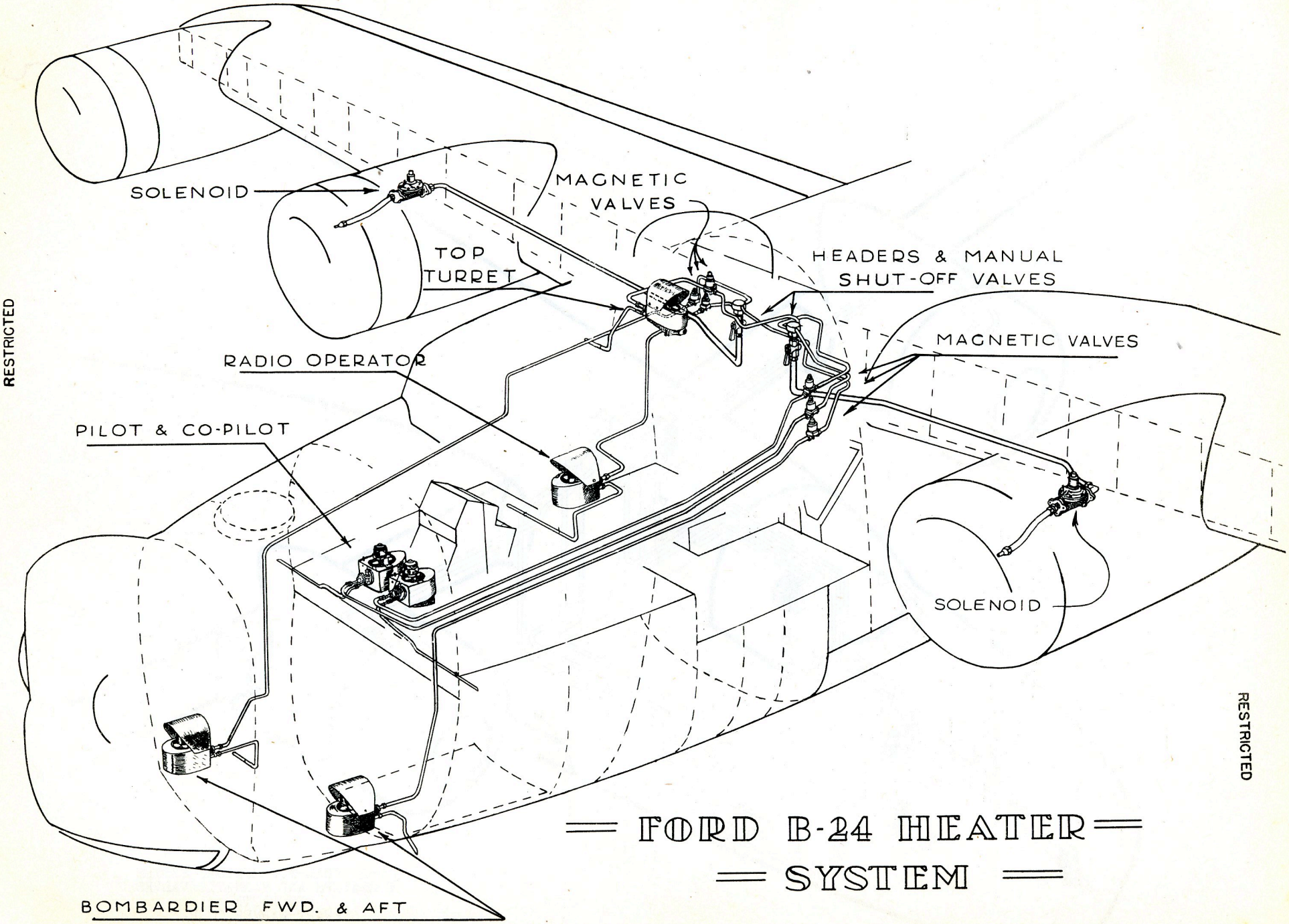
DE-ICER SYSTEM PROBLEMS AND PROCEDURES

4. Which instrument operates at 2" Hg. What unit regulates it?

5. If the suction gage shows 3.5" Hg., what may be 2 possible causes?



B-24 FUEL-AIR MIXTURE SYSTEM
6 HEATERS AND MAGNETIC VALVES
RESTRICTED
STEWART-WARNER CORP.



FORD B-24 HEATER SYSTEM

Job Sheet
II-11

HYDRAULICS

Airplane & Engine Mech Course (Special B-24)
MOFORD AIRPLANE SCHOOL

HEATING SYSTEM--OPERATION, INSPECTION, AND TROUBLE SHOOTING

AIM: To familiarize the student with the system units, their location and operation, proper operation of system, pre-flight and 50-Hr. inspection, as well as troubles which occur and the remedy for them.

REFERENCES:

Stewart-Warner Manual
T.O. 01-5EC-2
T.O. 03-70A-1

PART I:

Discussion and demonstration by the instructor showing the function and proper operation of individual units and the system as a whole.

PART II:

Locate the following units accurately and in order. This will give you an over-all knowledge of the system. Use mock-up airplane and the Stewart-Warner Manual.

1. Take-Off Fittings _____
2. Two Solenoid Shut-off Valves _____
3. Two Manual Shut-off Valves _____
4. Two Three-way Headers _____
5. Follow out all fuel-air mixture lines from the headers----it is not necessary to write this down.
6. Six Magnetic Shut-off Valves _____
7. Six Heaters (Names and Locations) _____
8. Master Heater Switch _____
9. Heater Relay _____
10. System Switches: (1) _____ (2) _____
11. Heater Fuse Box _____

PART III

PRE-FLIGHT INSPECTION AND TROUBLE SHOOTING: Perform the following pre-flight inspection on the ship mock-up, correcting any troubles that may occur. A voltmeter is available for checking electrical circuits.

1. Turn Master Heater Switch "ON".

   (a) Check clicking of heater relay.

2. Turn pilot's, co-pilot's and upper-turret system switch "ON".

   (a) Check clicking of three magnetic valves and one solenoid valve.

3. Turn "ON" the bombardier's forward, aft, and radio operator's heater switch.

   (a) Check clicking of three magnetic valves and one solenoid valve.

4. Check each igniter for heating.

   (a) Test by either cautiously applying finger to igniter or by use of a voltmeter. There should be at least 22 volts across igniter.

5. Check fan out-put at each heater.

6. Check heaters for security of mounting.

7. All heaters should be turned off for take-off.

PART IV:

50-HR. INSPECTION: (2 students on each heater).

1. Detach fuel-air mixture line from the nipple fitting at the heater.

2. Remove nipple fitting from heater.

3. Take out the flame arrestor. Clean in any good solvent, such as carbon-tet.
   NOTE: If solvent will not clean the arrestor, it is evident that the entire heater is in the same condition. Heater should be replaced.

4. Remove exhaust line and restrictor fitting.

5. Clean restrictor, making sure you do not enlarge the small hole.

6. Before replacing the fittings and lines, introduce a stream of low pressure air at the inlet hole of the heater. Air should come out freely at the exhaust port.

7. Re-install the fittings.

8. Check all electrical connections and the heater mounting bolts for security.

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GENERAL QUESTIONS

1. The take-off fitting is located on the _____ of the _____.

2. When the circuit switch is turned "ON", the unit which allows the fuel air mixture to pass through the fuel line is called the _____.

3. The fuel air mixture line in the leading edge of the wing is asbestos wrapped to prevent, _____.

4. The left hand header distributes the mixture from No. _____ engine to 1._____ 2._____ 3._____ heaters.

5. The right hand header distributes the mixture from No. _____ engine to 1._____ 2._____ 3._____ heaters.

6. The color identification for fuel air mixture lines is _____.

7. Heater exhaust is returned to the _____ of the _____.

8. The color identification for exhaust lines is _____.

Construction of Heaters

1. The flame arrestor prevents _____.

2. The unit in the combustion chamber which directs the fuel air mixture against the baffle cup is called the _____.

3. When the baffle cup is correctly placed in the combustion chamber the baffle side faces _____.

4. The electric coil which ignites the fuel air mixture is called the _____.

5. The unit which cuts off the current to the igniter is called the _____ and is located _____.

6. The function of the reigniter is to _____.

7. Combustion is completed when the burning gases strike the _____ and pass into the oven.

8. The copper fins around the oven serve to _____.

9. The exhaust or restriction fitting limits _____ and governs _____.

10. At 255°, the overheat switch will automatically turn off the heaters by cutting off the current to the _____, thus shutting off the flow of fuel-air mixture.

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Electrical

1. The heater master switch is located _____.

2. The heater circuit which includes the upper turret is energized by a switch located _____.

3. If the radio operator wants heat, the _____ _____ turns on a switch located _____.

4. The following four heaters have a separate ground wire circuit: 1. _____ 2. _____ 3. _____ 4. _____.

5. The defroster switch on the co-pilot's panel will operate fans on the _____ _____ heaters.

6. The heater fuse box is located _____.

7. The thermo-snap switch will break the contact to the _____ when the heater becomes hot.

8. Make a wiring diagram showing all connections from the heater terminal.

Operation, Care, and Inspection

1. To obtain the most efficient operation of these heaters, manifold pressure should be _____ hg.

2. These heaters will start between a manifold pressure range of _____ to _____ hg.

3. After they have started they will operate between a manifold pressure range of _____ to _____ hg.

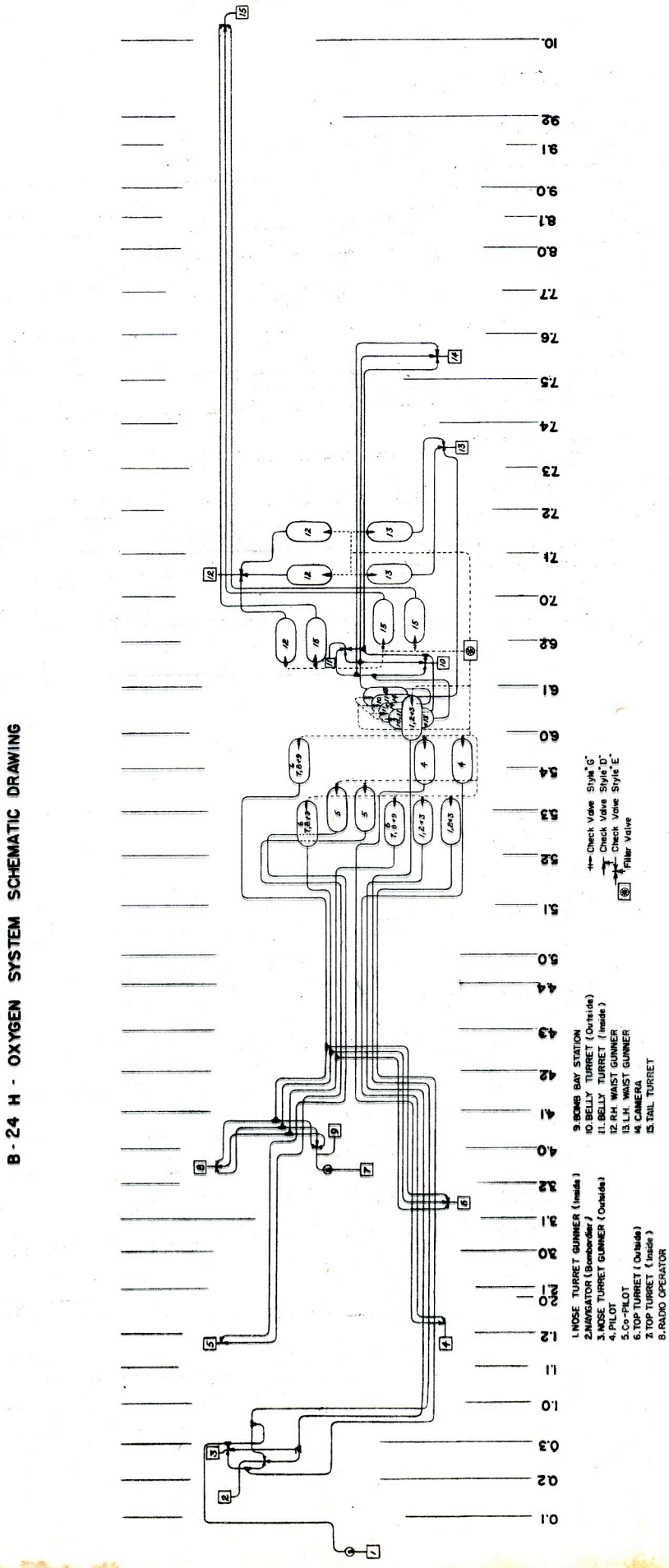
4. If heaters start smoking after being turned off, _____ _____.

5. If the restriction fitting shows deposits of aluminum, this indicates _____.

6. If one heater is inoperative, check 1. _____ 2. _____ 3. _____ 4. _____ 5. _____.

7. If all three heaters are inoperative, check 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____ 7. _____.

580TH TECHNICAL SCHOOL SQUADRON
Willow Run Airport
Willow Run, Michigan



FORD AIRPLANE SCHOOL
ARMY AIR FORCES

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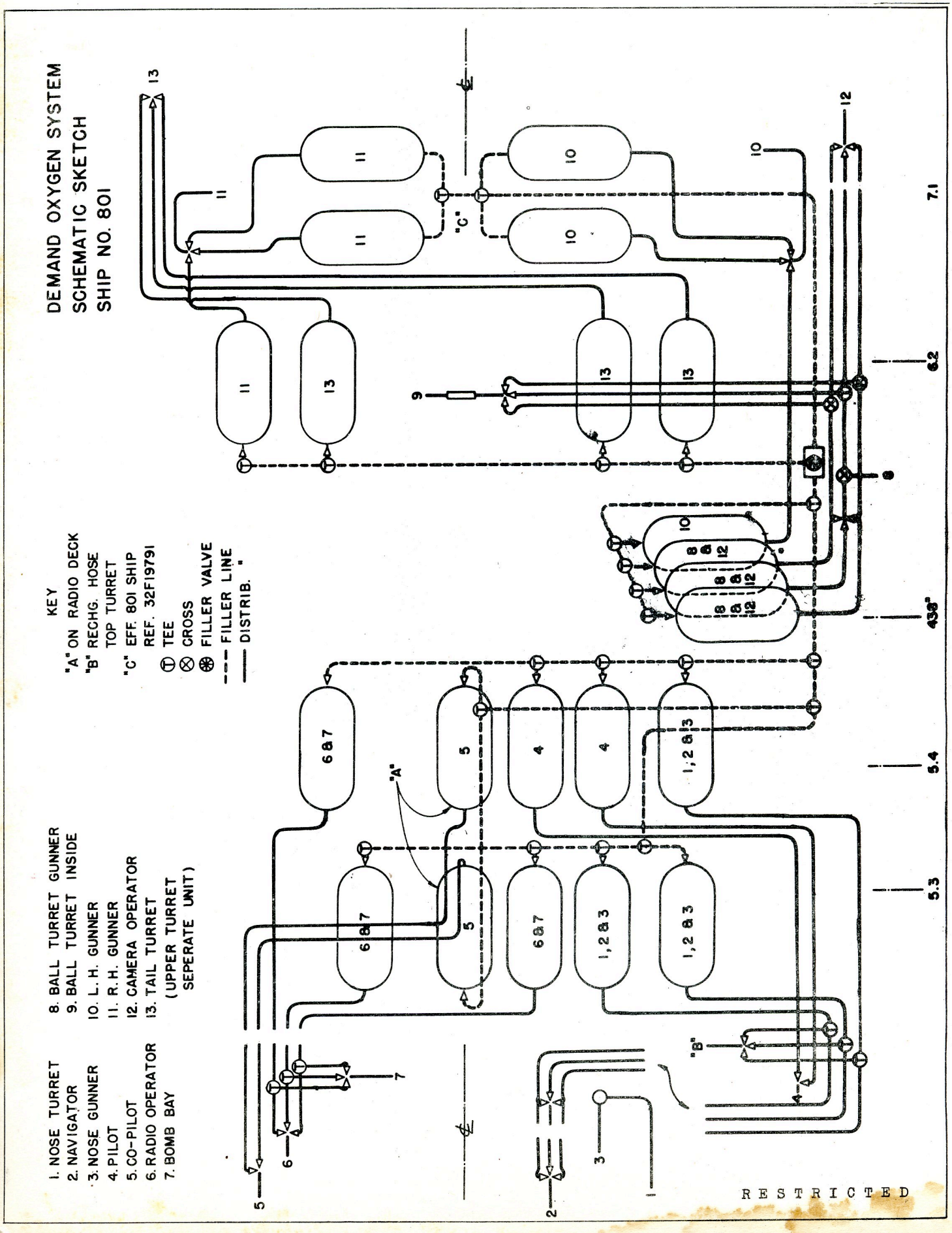

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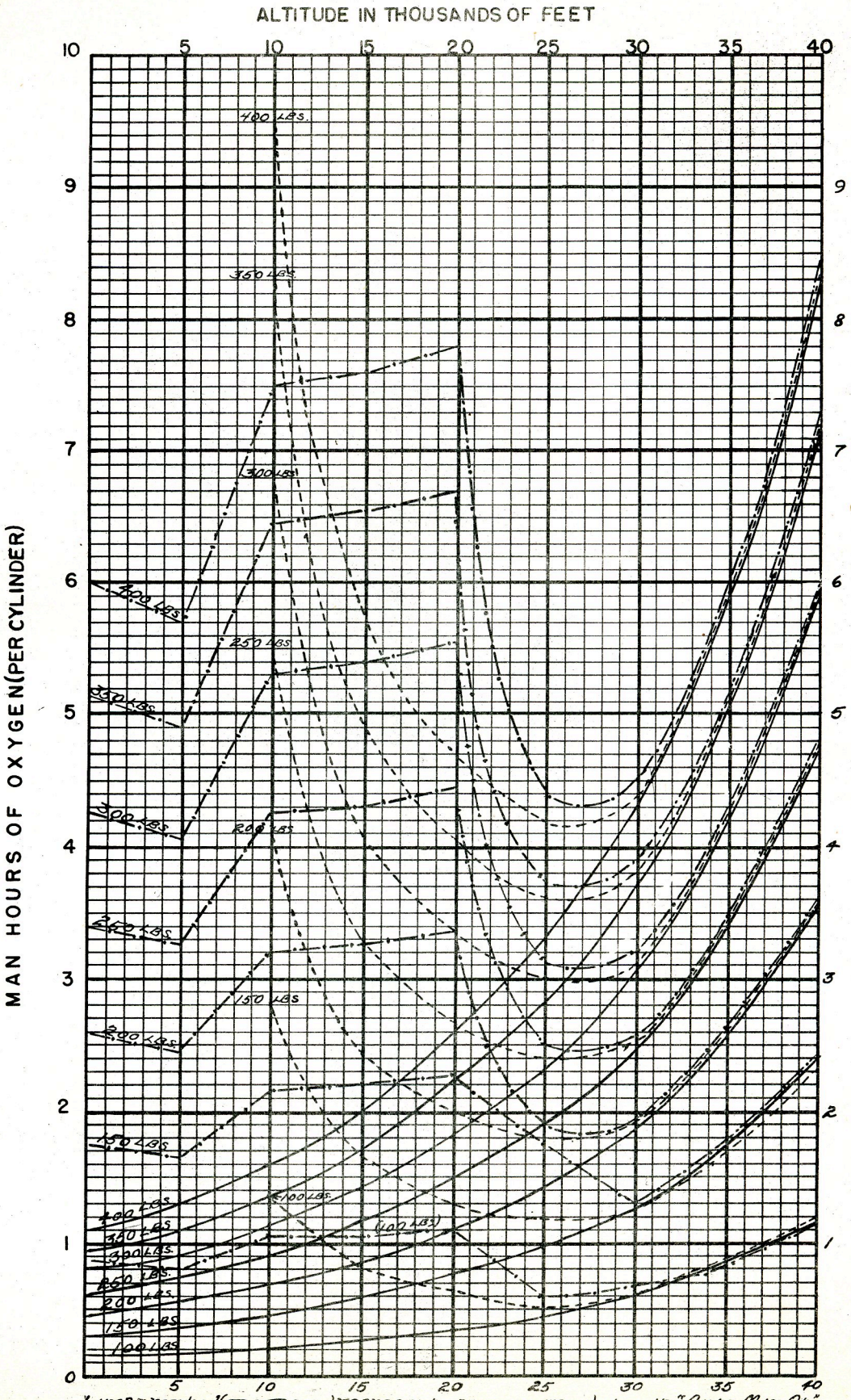

Lines marked (— · — · —) represent pioneer regulator in "Auto Mix On"
Lines marked (— — —) represent "Airco" regulator in "Auto Mix On"
Solid black lines represent both regulators in "Auto Mix Off"

Airplane & Engine Mech. Course (Special B-24)
FORD AIRPLANE SCHOOL

INSPECTING, CHARGING, AND TESTING OF THE OXYGEN SYSTEM

OBJECT: To familiarize you with the operation, inspection, maintenance and testing of the oxygen system on the B-24 Airplane.

I. Oxygen Supply:

1. The Airplane should be filled with oxygen of Specification _____ (See T.O. 03-50-1)

2. Welding oxygen and "Hospital" Oxygen contain _____, and are therefore unsatisfactory for use in Airplane Oxygen Systems. (See T.O.03-50-1)

3. High pressure oxygen cylinders should be plainly marked "Aviators Breathing Oxygen" and are _____ in color.

   It requires approximately 4 high pressure cylinders to completely charge the B-24 Oxygen System. When in doubt concerning the contents of a cylinder never place the contents in the oxygen System. (See T.O.03-50-1)

4. The drying cartridge in the recharging cart should be changed after using _____ storage cylinders. (See T.O. 03-50-1)

5. Why is it so important that oxygen be completely dry before introducing it into the Oxygen System? (See T.O. 03-50-1)

6. The oxygen filler valve on the B-24H and J is located aft of the left bomb bay section at station _____. Before using, make sure the filler valve is free of tape, dirt, or other dangerous foreign matter.

7. Oxygen filler lines are marked with a _____ _____ color. Distribution lines are marked _____.

8. Check the oxygen pressure at each of the regulator stations and record the results in the table below:

STATION	P.S.I.	STATION	P.S.I.	STATION	P.S.I.
*Nose Turret		Radio Operator		L.Waist Gunner	
Nose Gunner		*Upper Turret		R.Waist Gunner	
Bombardier		Bomb Bay		Aft Camera	
Pilot		*Ball Turret (I)		Tail Turret	
Co-Pilot		Ball Turret (O)			

*These stations are not in the mock-up Airplanes #1 and #2.

9. When fully charged the system pressure should be _____ p.s.i. (See T.O. 03-50-1)

10. After the recharging operation has been completed the filler line (a) should (b) should not be bled. (See T.O. 03-50-1)

II. Oxygen Equipment:- Description & Maintenance:

1. Oxygen lines are _____ inches in diameter (See T.O. 03-50-1)

2. Combination anti-seize and sealing compounds are used on (a) pipe threads, (b) straight threads, (c) tube flares. (Check two.)(See T.O. 03-50-1).

3. Three approved combination anti-seize and sealing compounds are : (T.O.03-50-1
   a. _____
   b. _____
   c. _____

4. Are the check valves used in this system spring-loaded? _____

5. The G-1 cylinders used in the system are (a) shatterproof, (b) non-shatterproof. The internal capacity of each cylinder is _____ cubic inches. (T.O. 03-50-1)

6. How long would one G-1 cylinder of oxygen last at 25,000 ft, using a Pioneer Regulator with "Auto-mix off"? _____ With "Auto-mix On" _____ (Consult "Duration Chart")

7. The charge carried by the walk-around bottle is _____ p.s.i. It is charged by means of the _____ hose. (T.O. 03-50-1)

8. The charge carried by the Bail-out bottle is _____ p.s.i. It is _____ in color. (03-50-1)

9. The A-12 demand oxygen Regulator automatically regulates the mixture of Oxygen and _____. (T.O. 03-50-1)

10. For normal operation the Auto-Mix Control should be in the (a) "On", (b) "Off" position. (T.O. 03-50-1)

11. When 100% Oxygen is desired on the ground, the Auto-mix must be in the (a) "On", (b) "Off" position. (T.O. 03-50-1)

12. If the demand regulator fails, it is necessary to open the _____ _____. (T.O. 03-50-1)

13. The instrument which indicates whether the user is getting oxygen is called a _____. (T.O. 03-50-1)

14. A _____ at each regulator station indicates the oxygen pressure available at that station (T.O. 03-50-1).

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III Check List for Inspection of Oxygen System:

1. Make sure the rubber gasket on the mask quick-disconnect fitting is in place. _____.

2. Approximately a 12 pound pull should be required to separate the mask quick-disconnect fitting from the mask-to-regulator hose. _____.

3. Make sure all clamps are in place on the mask-to-regulator hose. Check for tears, holes, kinks, or other damage. _____.

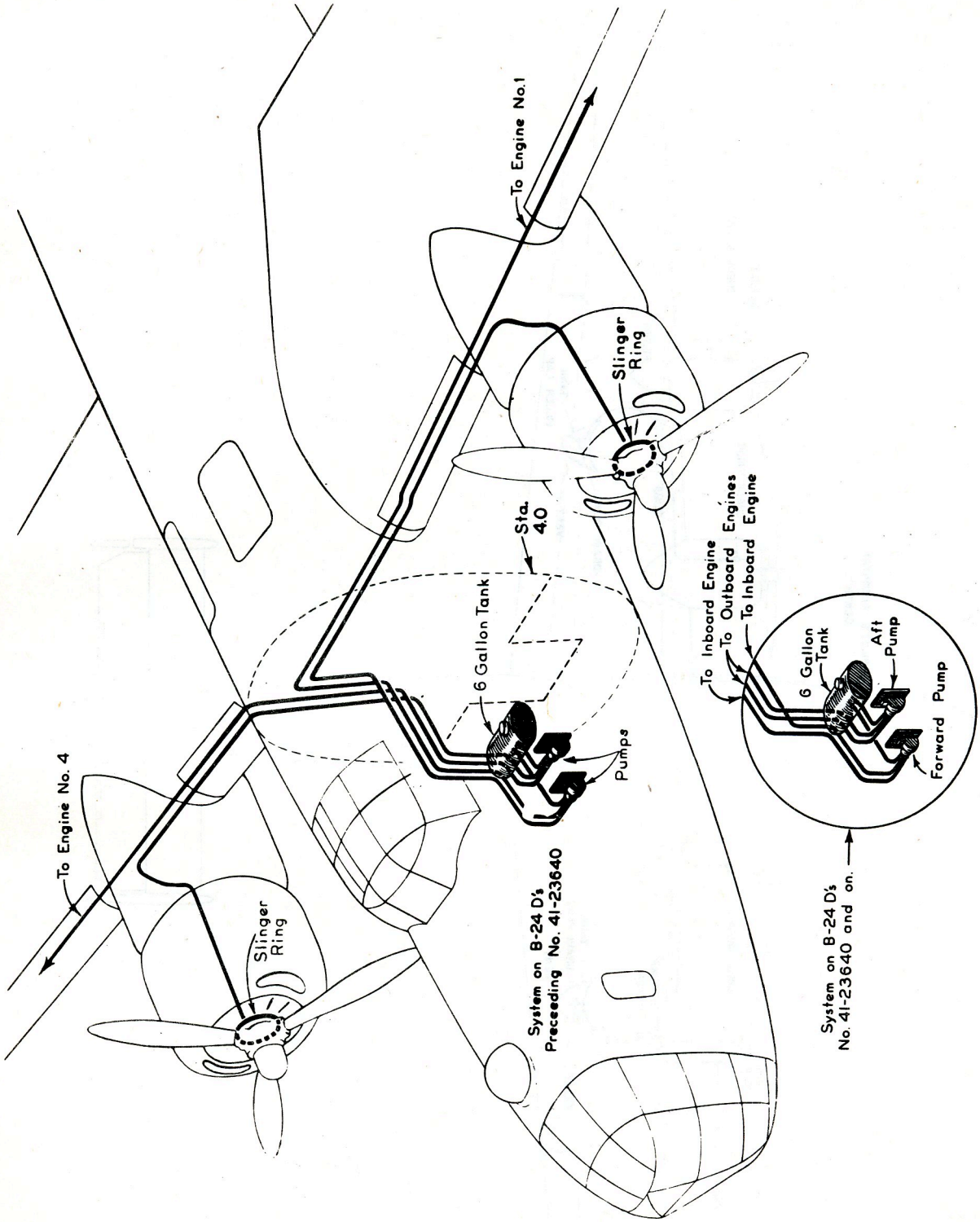
4. Check for ruptured or leaky diaphragm on regulator by blowing gently into the regulator through the mask-to-regulator hose. "Auto-Mix" and "Emergency" must both be off. _____.

5. Check for presence of washer at Regulator outlet and make sure knurled collar at outlet elbow is tight. _____.

6. Open the Emergency Valve on the regulator to see that oxygen flows. _____.

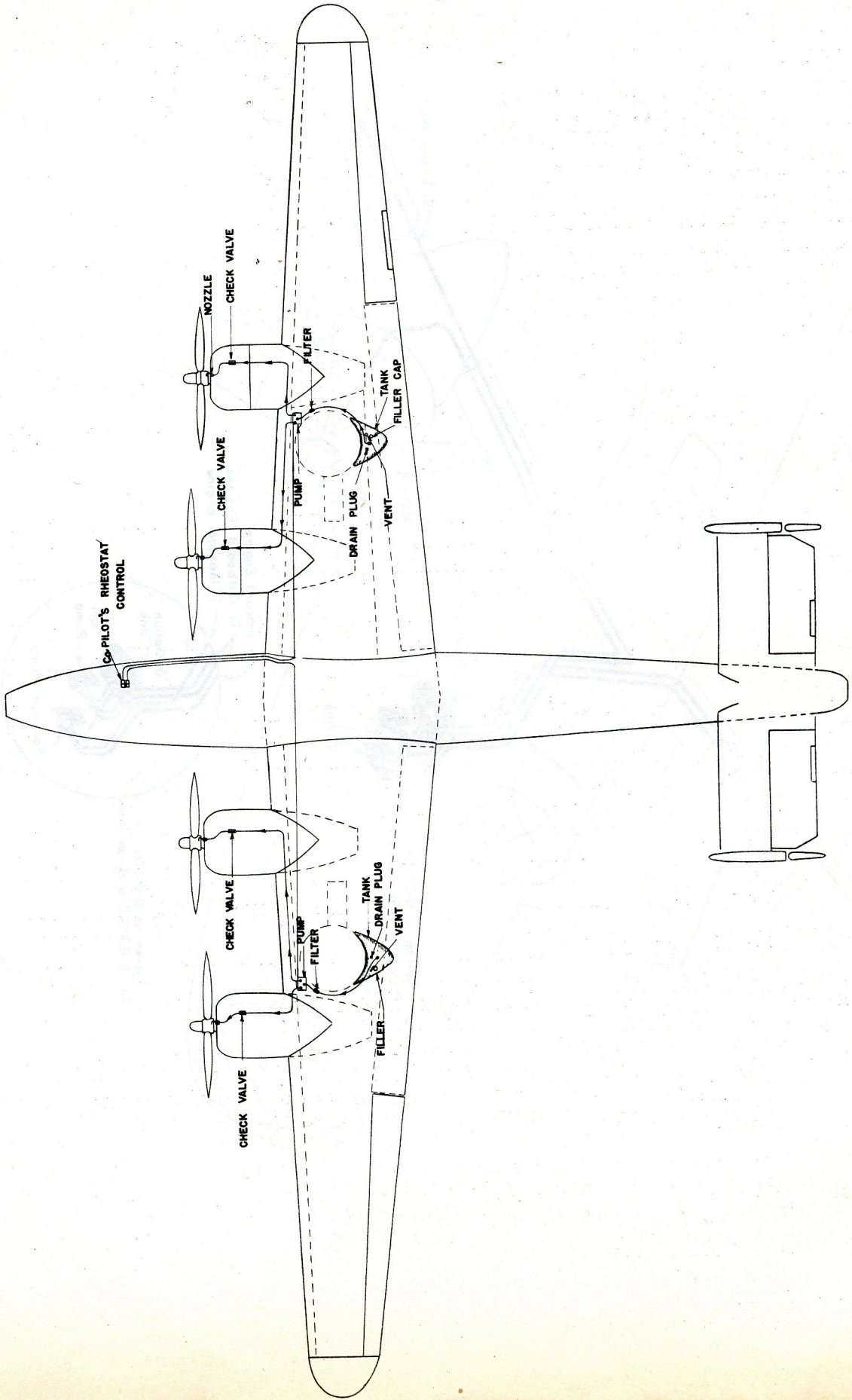
7. Working pressure at each station must be not less than 400 p.s.i. as shown on the pressure gage.

8. Check for presence and charge of walk-around bottle at each station. _____.


To Engine No. 4
Slinger Ring
To Engine No. 1
Slinger Ring
Sta. 4.0
6 Gallon Tank
Pumps
System on B-24 D's Preceeding No. 41-23640
To Inboard Engine
To Outboard Engines
To Inboard Engine
6 Gallon Tank
Aft Pump
Forward Pump
System on B-24 D's No. 41-23640 and on.

VE-830

RESTRICTED



B 24-H ANTI-ICING SYSTEM DIAGRAM

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

ANTI-ICING SYSTEM

REFERENCES:

T.O. 03-1-5 (Eclipse Pumps)
T.O. 03-1-6 (Eclipse Pumps)
T.O. 03-35A-7 (Weldon Pumps)
T.O. 01-1-87 (Fluid Spec.)

PART I: Locate the following Units:

1. Anti-Icing Tank:

   (a) Early Planes: (1)_____ (2)_____

   (3) _____

   (b) Current Model (B-24M) _____

2. Fluid Filter:

   (a) Early Planes: (1)_____ (2)_____

   (3) _____

   (b) Current Model (B-24M) _____

3. Anti-Icing Pumps:

   (a) Early Planes: (1)_____ (2)_____

   (3) _____

   (b) Current Model (B-24M) _____

4. Check Valves: _____

5. Slinger Ring: _____

6. Rheostat Control: _____

PART II: Procedure for Operation on Mock-up Airplane.

1. Check fluid level in tank and fill if necessary.

   CAUTION: Be sure quart jars for catching fluid on mock-up are emptied into the main tank before operating the system.

2. With one person operating the Rheostat Control and one at each engine mount, operate the system and check the difference in output of the pumps with three different settings of the rheostat.

3. Empty quart jars into main tank when through operating system.

4. On the airplane, the propeller slinger ring should be cleaned after each time the pump is used in order to prevent dirt and dust from accumulating and clogging the system.

Airplane & Engine Mech Course (Special B-24
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PART III: General Questions on Anti-Icing System

1. On the planes which have the tanks in the wheel wells does one pump supply anti-icing fluid to the inboard props while the other supplies the outboard props? _____.

2. What type fluid is used? _____ Spec. No. _____.

3. What size tubing is used? _____.

   What is the color identification? _____.

4. Indicate capacity of tank.

   (a) Early planes: (1)_____ (2)_____ (3)_____

   (b) Current Model (B-24M) _____.

5. What type pump is used?

   (a) Early planes: (1)_____ (2)_____ (3)_____

   (b) Current Model (B-24M) _____.

6. What is the output capacity of the pumps?

   (a) Eclipse _____

   (b) Weldon _____

7. How often should the motor brushes be checked? _____.

   What is the minimum length permitted? _____.

8. Why should the Rheostat be set at maximum capacity when first starting pumps?

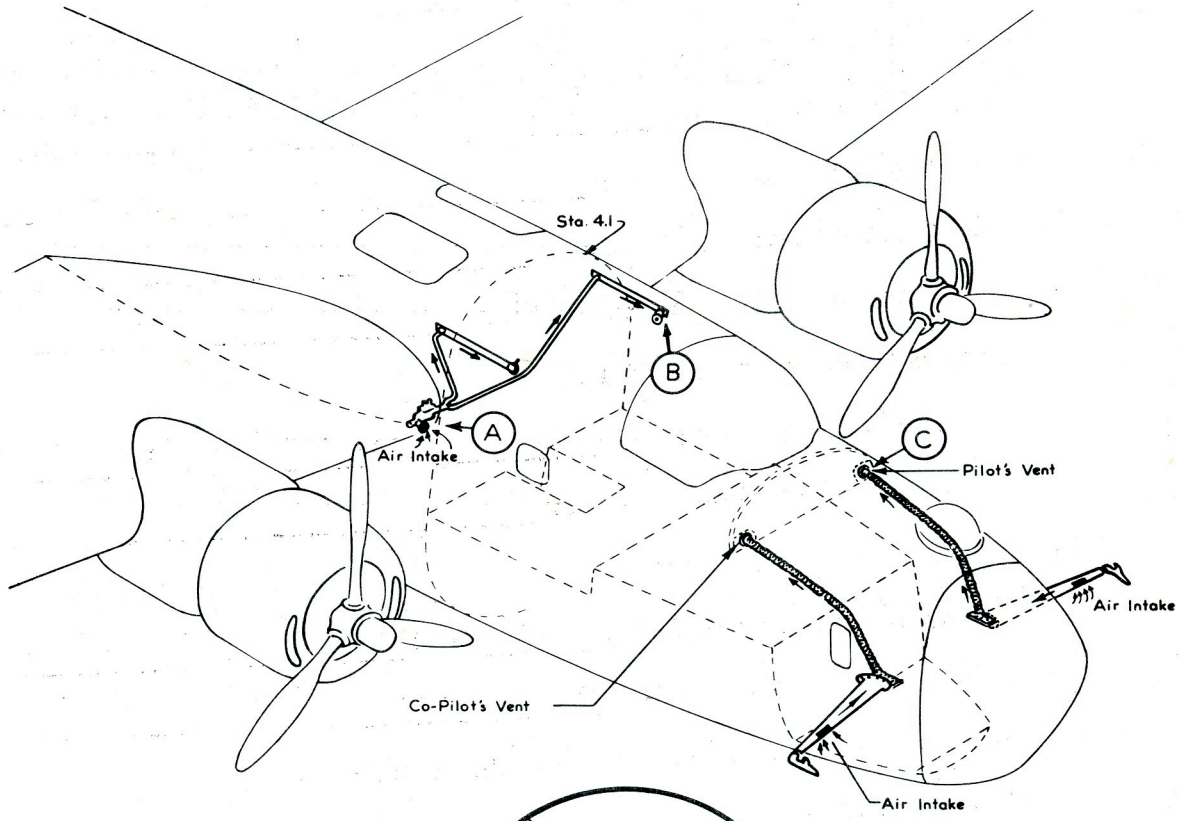
   _____.

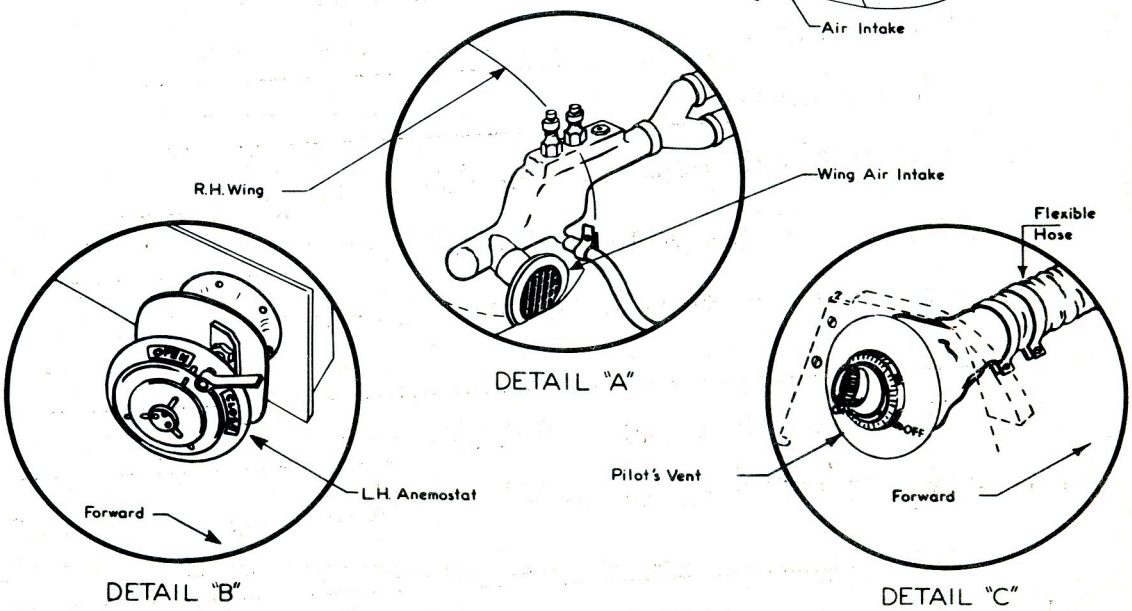
9. Is it necessary to prime the pumps? _____.

10. Why is the tank removed or drained before going into combat? _____

    _____.

11. Make a schematic sketch of the B-24J Anti-Icing System.


Sta. 4.1
A
B
C
Air Intake
Pilot's Vent
Air Intake
Co-Pilot's Vent
Air Intake


R.H. Wing
Wing Air Intake
DETAIL "A"
Flexible Hose
Pilot's Vent
Forward
L.H. Anemostat
Forward
DETAIL "B"
DETAIL "C"

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VENTILATION

Aim:

Location and Identification of Units and Lines in the Ventilation System.

Reference:

T.O. 01-5EC-2

Introduction:

Fresh air must be brought from an outside source for crew members.

PART I: Radio Compartment Ventilation (Models prior to B-24 M).

1. Where is the intake screen located?

2. What line or unit is connected to this screen?

3. Can this unit be drained? How?

4. What are the resistance bulbs for?

5. At what station does this line lead over to the left side of the fuselage?

6. What are the air regulators in the Radio Compartment called? How many are there?

7. B-24 M - How is the Radio Compartment ventilated on this model?

PART II: Pilot and Co-Pilot Ventilation

1. From what source do the Pilot and Co-Pilot get their Ventilation?

   a. Early Models

   b. Current Model (B-24 M)

2. How does this air lead to the Instrument Panel?

3. Is there a "Shut-Off" on the regulators?

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OPERATION AND INSPECTION OF ENGINE FIRE EXTINGUISHER SYSTEM

Part I. The engine fire extinguisher system consists of the following units and installations:

1. CO_2 Cylinders: Type A-12 - there are two of these in the nose wheel compartment along the right side of the fuselage.
   (a) When charged, these cylinders contain liquid CO_2 which is forced out by means of gas pressure above the liquid content.
   (b) Amount of charge is determined by weight. Weight of both cylinder and CO_2 charge is stamped separately on each cylinder.
   (c) Date of charging is stamped on cylinder.
   (d) If the weight of the cylinder has decreased by 7 ounces or more from "Full" weight stencilled on cylinder, it must be replaced. (06-20-3, p. 5 and 01-5EC-2, p.518)
   (c) Must be weighed at the end of the first 50-hour inspection period and every 6 months thereafter.

2. Safety Disc: Installed in each valve assembly on the cylinder and designed to rupture at 2200 to 2800 p.s.i. which is below the test pressure to which the cylinder is subjected. (06-20-3, p.1)

3. Discharge Indicators - Small red discs visible on outside of fuselage. When broken it indicates a discharged CO_2 cylinder due to a ruptured safety disc. Connected by tubing to pressure cylinders. These red discs must be checked for ruptured condition in preflight inspection.

4. Manifold by-pass - connects the lines from the CO_2 cylinders so that it is possible to direct the discharge from either cylinder to any engine.

5. Check valve - in line between each cylinder and the manifold by-pass to prevent charge from a full cylinder backing up into a discharged cylinder.

6. Control Panel: - located on floor to right of Co-pilot. This panel consists of two Selector Valves designed to direct the discharge to any engine desired and two Pull Handles which are connected by cables to the quick-release valves on the CO_2 cylinders.

7. Discharge Ring - located in each engine nacelle between the power section and the accessory section. It is perforated at frequent intervals for the escape of the discharged CO_2.

8. General features:
   (a) Gas pressure above the liquid CO_2 forces the CO_2 through a siphon tube, the cylinder valve, tubing, selector valve, and perforated ring
   (b) CO_2 discharges in form of gas -keeps xygen from fire and also has a cooling effect.
   (c) CO_2 in either cylinder may be discharged into any one of 4 engine nacelles.

PART II. Check and indicate the location of each of the following units:

1. CO_2 cylinders _____

2. Quick-Release Valves _____

3. Discharge Indicator discs _____.

4. Manifold by-pass _____.

5. Check valves _____.

6. Control Panel _____.

7. Discharge Rings _____.

Part III In removing CO_2 cylinder for weighing or replacement follow these steps:

1. Disconnect Control cable by taking screw out of cam lever on cylinder valve.

2. Disconnect discharge tube from valve assembly. Take care that brass bushing inside of nut is not dropped or damaged.

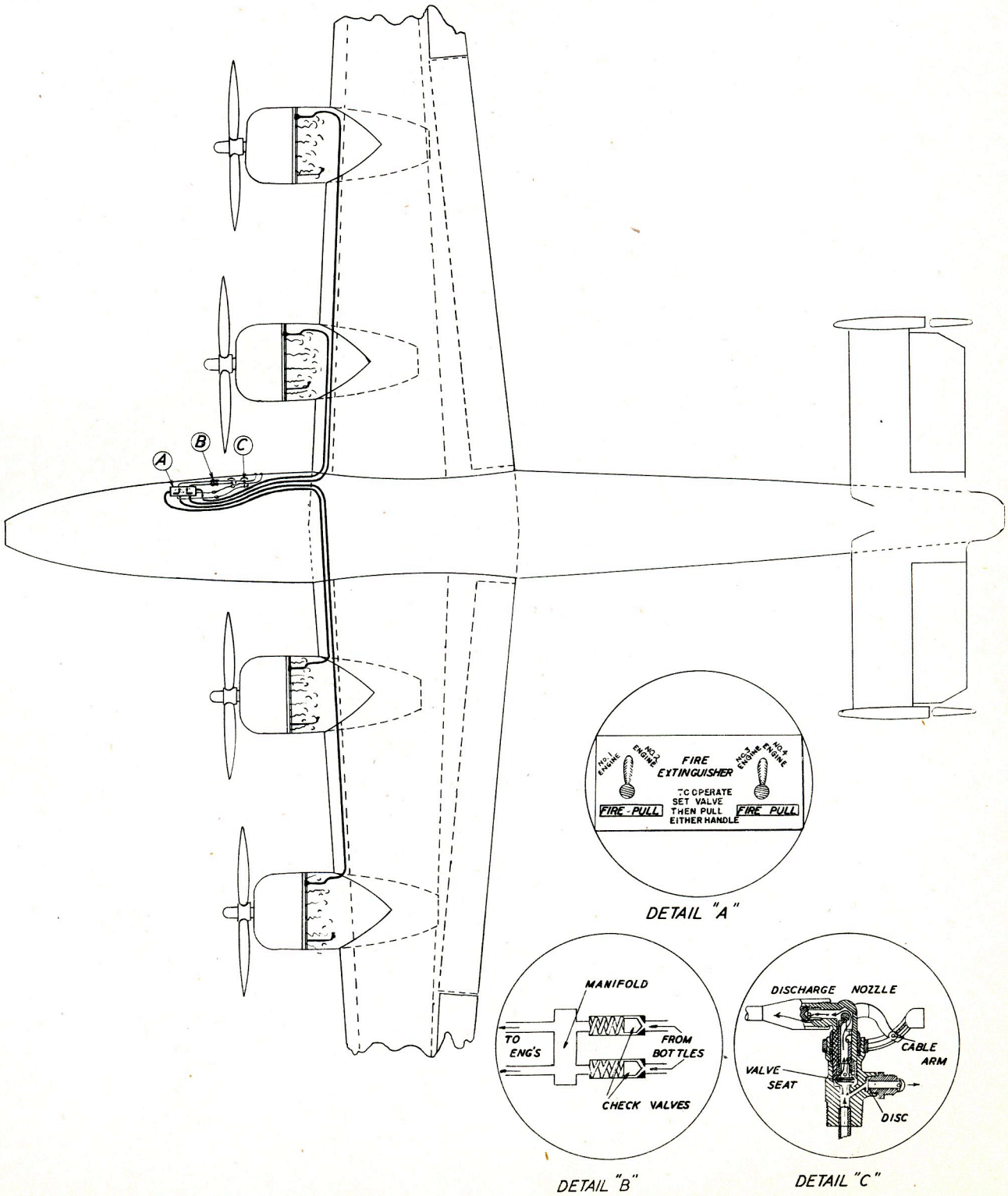
3. Disconnect flexible overboard blow-out line by loosening the middle nut of the three nearest the valve itself.

4. Remove bracket which serves as a guide to control cable.

5. Unhook the strap holding the cylinder in its mounting and remove cylinder.

6. For installation, reverse the above steps. Make sure that when cable has no eye at the end fastened to cam lever, the cable is run on the underside of the screw holding it - if put on top side, the screw will work loose when cable is pulled.

Ford B-24 Carbon Dioxide Fire Extinguisher System



AIRPLANE INSPECTIONS

References:

T. O. 00-20A-1
T. O. 00-20A-2
01-5EC-2

Column No. Form 41B	Inspections Required	Symbols Denoting Condition	Remarks pertaining to defects, replacements, etc.
	HYDRAULIC SYSTEM		
	PREFLIGHT		
	(To be performed prior to the first flight of day)		
10.	Before Starting Engines:		
	1. Check for proper level of fluid in hydraulic fluid reservoir. Fill with hydraulic fluid, Specification AN-VV-O-366B.		
	NOTE Follow instructions stencilled on the reservoir.		
	CUATION Do not spill hydraulic fluid on electrical wiring.		
	2. Check to see that suction line valve at hydraulic reservoir is open. (Normal position is horizontal.)		
	3. Visually check all couplings and fittings of the system for signs of leakage.		
	4. Check for proper functioning of electric hydraulic pump and of pressure switch.		
	NOTE If the electric pump does not run when the manual switch is turned "on", reduce pressure in the right accumulator by operating bomb bay doors with utility valve.		
	5. Check operation of brakes and parking brake control. Check brake hydraulic pressure which should be between 900 and 1100 p.s.i. If pressure is low, recharge the accumulators with the hand pump or the electric driven pump.		

Column No. Form 41B		Symbols Denoting Condition	Remarks pertaining to defects, replacements, etc.
	CAUTION To protect the batteries, the electric pump will be used only when the auxiliary power unit or main generators are charging, or when an external source of power is available. If no generators are being operated to charge the batteries, the hydraulic hand pump must be used as the source of pressure. In extremely cold weather, initial operation of the hydraulic system must be accomplished with extreme care. In case the parking brakes have been left on, they must be released and reapplied very slowly several times to prevent cracking of the brake expander tubes.		
11.	6. Check operation of Pilot's emergency bomb pull handle.		
	7. Check operation of bomb doors with the selector valve, utility valve and hand cranks.		
10.	DURING ENGINE WARM UP 8. Check the hydraulic system gage to see that 900-1050 p.s.i. pressure exists in the system.		
	9. Check kick-back of landing gear selector valve from "down" position and flap selector valve from both "up" and "down" position, operating flap with either engine-driven pump, electric-driven pump, or hand pump; at the same time check for freedom of flap movement and proper operation of flap indicator.		
	AFTER FLIGHT		
30	1. Check for proper fluid level in hydraulic system reservoir. To fill, follow instructions stencilled on the reservoir.		
11	2. Check bomb doors for condition and proper operation.		

Column No. Form 41B	Inspections Required	Symbols Denoting Condition	Remarks pertaining to defect, replacement, etc.
	3. Set parking brakes.		
	CAUTION		
	Allow brake drums to cool thoroughly before setting the parking brakes, in order to prevent damage to the brake expander tubes.		
	DAILY		
	(To be performed at any time during the day)		
30	1. Inspect all hydraulic units and valves for leakage.		
	2. See that the suction line valve at the hydraulic reservoir is open. (Normal position is horizontal)		
	3. If airplane has been parked for any length of time, check brake pressure gages. If pressure is below 700 lbs., recharge the accumulators with the hand pump or the electric driven pump.		
	4. Check operation of the hand and electric driven pumps by extending the flaps.		
	5. Turn handle of the Cuno strainer one full turn.		
	6. Check operation of the brakes and parking brake control.		
	7. Check ease of operation of the bomb doors.		
	25-HOUR INSPECTIONS		
	(Perform preflight and daily inspections as usual in addition to this inspection)		
39	1. Check accumulators once every 7 days or once each 25 hours of flight, whichever time elapses first, to insure that proper air pressure is maintained. To check for air pressure: discharge hydraulic pressure from accumulators (right hand or lower accumulator first by operating bomb door utility valve, then left hand or upper accumulator by stepping on brake pedals)		

Column No. Form 41B	Inspections Required	Symbols Denoting Condition	Remarks pertaining to defects, replacements, etc.
	and, at the same time while discharging an accumulator, watch the brake pressure gage for the respective accumulator - the point at which the gage needle drops suddenly to zero is the air pressure reading of the accumulator. If the air pressure in either accumulator is below 600 p.s.i. charge the accumulator with an air booster pump to not over 650 p.s.i.		
	CAUTION Do not use gas from CO_2 or oxygen cylinder.		
39	2. Check for leakage from the accumulators and check that accumulators will operate brakes and bomb doors.		
	3. Check hydraulic hand pump for general condition and functioning. Examine for external leakage, unusually weak operating linkage, and condition and security of pump mounting.		
	4. Check power brake control valve for external leakage at push rods, push rod retainer units, housing end caps and fluid line connections.		
	5. Inspect all other valves, fluid lines and connections for leaks, security of anchorage, chafing or wear due to vibration, dents and cracks.		
39	6. Inspect swivel joints for external leakage around spindle at packing retainer cap. Internal leakage results in sluggish operation of the respective landing gear.		
	7. Remove plug at bottom of Cuno strainer and drain sump.		
22	8. Check the manual and pressure switches for the electric-driven pump for positive operation and freedom from sticking.		

Column No. Form 41B	Inspections Required	Symbols Denoting Condition	Remarks pertaining to defects, replacements, etc.
	50 HOUR INSPECTIONS		
	(Perform preflight, daily and 25-hour inspections as usual in addition to this inspection.)		
39	1. Inspect brake control valves for proper operation.		
	2. Inspect landing gear and nose wheel gear cylinders for proper gear travel.		
	3. Remove and clean Cuno Oil Filter after first 50 and 100 Hours thereafter.		
	4. Check hydraulic pumps for security of mounting and proper operation.		
	100-HOUR INSPECTIONS		
	(Perform in addition to inspections of lesser periods)		
39	1. Check security of all hydraulic lines.		
	2. Electric-driven pump motor: check for security of mounting, safety wiring, condition of housing, condition of brushes and commutator.		
	300-HOUR INSPECTIONS		
	(Perform in addition to inspections of lesser periods.)		
39	1. Disconnect line at one of wheel brakes for each power brake control valve, and disconnect reservoir return line at power brake control valves. Charge accumulators to normal pressure and check for leakage with brakes in "OFF" position. No leakage should be evident at end of 15 minutes.		
	2. Reconnect reservoir return line. Then connect a "Tee" fitting to the disconnected wheel brake lines to permit the attachment of an hydraulic pressure gage and bleeder valve of needle		

Column No. Form 41B	Inspections Required	Symbols Denoting Condition	Remarks pertaining to defects, replacements, etc.
	type to permit controlled escape of small quantities of fluid. Apply brakes until 150 to 200 p.s.i. registers on the gages. Then increase the pressure with the hand pump and decrease pressure with the bleeder valve in small amounts. Brake control valves should compensate for pressure change within 25 p.s.i. of original pressure.		
	3. Apply brakes until maximum pressure is reached. This should not exceed 250 p.s.i. and may be adjusted by varying the length of the connector links attached to brake valve actuating levers.		
	4. Place brakes in "parked" position and check for pressure drop, which should not exceed 5 p.s.i. in 30 minutes. Excessive pressure drop is evidence of internal leakage and brake control valve should be removed from airplane and overhauled.		
	500-HOUR INSPECTIONS		
	(Perform in addition to inspections of lesser periods)		
39	1. Inspect and test landing gear, wing flap and bomb door selector valve kick-back settings. Check main system and auxiliary pump system relief valves. Check setting of wing flap and bomb door relief valves. Adjust any setting to proper pressure, if found to be out of adjustment.		
	Landing gear up 1100 ± 50		
	down 850 ± 25		
	Wing Flap: up 750 ± 25		
	down 450 ± 25		
	Bomb Doors: open 600 ± 25		
	closed 1000 ± 25		
	Bomb door relief valve 750		
	Wing flap relief valve 500		
	Main system Relief Valve 1250		
	Auxiliary system relief valve 1300		

Column No. Form 41B	Inspections Required	Symbols Denoting Condition	Remarks pertaining to defects replacements, etc.
	NOTE Use hand pump to check all these settings.		
	SPECIAL INSPECTIONS		
39	Wing Flaps: Hydraulic check to be made after inspection of control surface rigging: 1. Check cylinder for bottoming at both ends.		
	2. Check operation of flap with position indicator.		
	3. Check "kick-back" of selector valve to neutral at end of both "down" and "up" operation using pressure gage on instrument panel: "down" 450 ± 25, "up" 750 ± 25.		
	4. Check to insure that wing flap relief valve setting is at least 25 p.s.i. above selector valve kick-back from the "down" position.		
	5. Retract flap using the auxiliary pump. Check pressure gage for smooth operation as sudden rises in pressure indicate friction characteristics in flap operating mechanism,		
	6. Operate flaps both "up" and "down" once, using hand pump in open center system.		
39	7. Bomb Doors: Open and close 3 times, using bombardier's selector valve. Check kick-back pressure, also check indicators for "open".		
	8. Check emergency bomb door operation.		
	9. Electric-driven hydraulic pump "cut-out" pressure should not exceed 1175 p.s.i. Cut-out pressure must be high enough to allow landing gear selector valve to return to neutral from "up" position before pressure switch stops the pump.		
	10. Automatic pressure switch must not cut-out before unloading valve kick-out in charging the accumulators. The pressure switch must cut-in before the unloading		

Column No. Form 41B	Inspections Required	Symbols Denoting Condition	Remarks pertaining to defects, replacements, etc.
	valve kicks-in, when discharging the accumulators.		
	11. Check landing gear selector valve kick-back pressures: "Up" 1100 ± 50 , "down" 850 ± 25		

Column No. Form 41B	Inspections Required	Symbols Denoting Condition	Remarks pertaining to defects, repalcements, etc.
	TAIL TURRET HYDRAULIC SYSTEM		
	PREFLIGHT		
	(To be performed prior to the first flight of the day)		
12	1. Check operation of shut-off switch on actuating panel;		
	2. Check fluid level in hydraulic power unit reservoir. Fill to red mark on sight gage with hydraulic fluid Spec. No.AN-VV-O-366b. Capacity of reservoir is approximately 1.5 gallons.		
	3. Check for proper air pressure of 600 lbs. in accumulator before starting motor.		
	4. Clean oil filter by turning handle one complete revolution.		
	5. Check for leaks in hydraulic system.		
	6. Check for creep in turret control valve and for leaks.		
	7. Check to see that by-pass valves are closed.		
	8. Check for smooth operation of turret in train at high and low speeds.		
	9. Check rotating cable tension. Adjust by turning turnbuckles which are anchored in the fuselage. The cables should have enough tension in them to prevent any appreciable horizontal play in the turret, yet they must not be so tight as to cause a "growling" of the rotating mechanism when it is in operation.		
	AFTER FLIGHT		
12	1. Check for free rotation and ease of operation.		
	25-HOUR INSPECTIONS		
	(Perform preflight and daily inspections as usual in addition to this inspection)		

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Column No. Form 4-B	Inspections Required	Symbols Denoting Condition	Remarks pertaining to defects, replacements, etc.
12	1. Check for ease of operation and freedom of movement.		
	2. Check switches for condition, operation and wiring connections.		
	50-HOUR INSPECTIONS		
	(Perform preflight, daily and 25-hour inspections as usual in addition to this inspection)		
12	1. Check system for leakage.		
	2. Check to see that sump on bottom of oil filter is drained.		
	3. Check for proper fluid level in the hydraulic reservoir.		
	100-HOUR INSPECTIONS		
	(Perform in addition to inspection of lesser periods)		
12	1. Inspect electric-driven hydraulic pump and unloading valve for proper functioning.		
	2. Check accumulator air pressure (should be 600 p.s.i.) Procedure: Use up all hydraulic pressure stored up in accumulator by raising and lowering guns with hydraulic control valve and with manually operated switch for the electric-driven pump in the "off" position. Then use air pressure gage in valve at bottom of accumulator.		

Column No. Form 41B	Inspections Required	Symbols Denoting Condition	Remarks pertaining to defects, replacements etc.
	FUEL SYSTEM		
	PREFLIGHT		
	(To be performed prior to the first flight of the day)		
10	Before Starting Engines:		
	1. Inspect self-sealing fuel tanks for evidence of deterioration.		
	2. Inspect the structure surrounding the cells for any leakage of fuel between the cells and the surrounding structure which may be caused by improper attachment of fittings or particular failure of any tank's outlet connections. Such failures will be immediately indicated by leakage of fuel to the outside of the airplane.		
	3. Check condition, security and safetying of filler caps and gaskets.		
	4. Drain main fuel strainers.		
	5. Make sure that all drain cocks and plugs are properly safetied.		
	6. Drain the auxiliary wing cell drains.		
	7. Drain the cell manifold drains.		
	8. Drain the sumps in the sight gage fuel lines.		
	9. Check the quantity of fuel on the airplane Flight Report, Form No. 1A. This check must be made on the day the airplane is to be flown, prior to the first flight of the day. Checks made on a previous day cannot be considered part of the preflight inspection prescribed by these instructions.		
	NOTE		
	Do not drag servicing hose over deicer shoes. Be sure to discharge static electricity from De-Icer shoes before refueling. Check if airplane is grounded and it will be necessary for any crew member to be certain that the static charge in his body is first discharged to some other part of the airplane structure before he touches any metal adjacent to an open filler neck.		

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Column No. Form 41B	Inspections Required	Symbols Denoting Condition	Remarks pertaining to defects, replacements, etc.
	During Engine Warm-up		
10	10. Check fuel pressure Desired 17 p.s.i. Maximum 18 p.s.i. Minimum 16 p.s.i.		
	11. Check fuel sight gages for fuel quantity.		
	AFTER FLIGHT		
19	1. Be sure that static electricity on de-icer shoes has been completely discharged by a grounded wire brush, or some similar means. (See T.O. 01-5EC-2, pages 24 and 50)		
	2. Service all fuel tanks to full normal supply and enter quantities on Form No. 1A at completion of the day's flying. Make visual check of airplane while servicing.		
	DAILY		
	(To be performed at any time during the day)		
19	1. With engines running and fuel booster pumps on, inspect carburetor and fuel line connections for leakage, particularly at drain plugs, passage plugs and parting surfaces of body castings.		
	2. Check fuel pressure gages with booster pumps running.		
	3. Check booster pump switches for proper operation.		
	4. Run bomb-bay catwalk booster pump and transfer panel pump (if it is installed) momentarily to test the proper running order. CAUTION Do not operate bomb-bay catwalk booster or transfer pump unless suction side of pump has been disconnected, or until steps have been taken to avoid pumping fuel into tanks already full.		
	5. Inspect selector valves for proper functioning		
	6. Inspect engine-driven fuel pumps for security of mounting and for safety wiring.		

Column No. Form 41B	Inspections Required	Symbols Denoting Condition	Remarks, pertaining to defects replacements, etc.
	7. Inspect fuel vents and overflow lines for security of anchorage; see that the lines are open and that the lines extend below cowling.		
	8. Drain main fuel strainers and fuel tank sumps and resafety all drains.		
	9. Inspect fuel tank self-sealing cells against raised or blistered areas, loose seams or other defects.		
	10. Check fuel sight gages for cracked or discolored indicating tubes. See that the valves in the lines from the fuel tanks are open.		
	25-HOUR INSPECTIONS		
	(Perform preflight and daily inspections as usual in addition to this inspection)		
23	1. With fuel pressure up for all engines inspect fuel lines for leaks, particularly at connections and sharp bends.		
	NOTE This inspection should be made with engine cowling removed.		
	2. Inspect insecurity of line anchorage, wear due to vibration or chafing, condition of hose connections, tightness of connections, chafing or cutting into lines by clamps, screws, bolts, etc.		
	3. Inspect all fuel overflow or drain lines for insecurity of mounting, kinks, breaks or stoppage.		
	4. Check to see that drain lines extend beyond the nacelle cowling or fuselage. This is necessary in order to insure against vapors collecting in the nacelles or fuselage.		
	5. Inspect engine-driven fuel pumps for evidence of leakage and for security of mounting and proper operation.		

Column No. Form 41B	Inspections Required	Symbols Denoting Condition	Remarks pertaining to defects replacements, etc.
	6. Inspect vent opening in relief or by-pass valve cover plug by inserting a No. 60 drill or 0.040" wire into the vent opening. (T.O. 03-10EA-1)		
	7. Remove and clean all fuel strainers and inspect screens for defects. Clean strainer bodies. If screens show evidence of self-sealing gas tank failure, refer to airplane handbook. Replace screens and resafety drain valves.		
	8. Inspect for deterioration and swelling of self-sealing tanks. T.O. 03-10-9.		
	50-HOUR INSPECTIONS		
	(Perform preflight, daily and 25-hour inspections as usual in addition to this inspection)		
35	1. Drain self-sealing tanks and refill to check capacity. If capacity is more than 5% less than original, cells will be opened to determine the cause.		
	100-HOUR INSPECTION		
	(Perform in addition to inspections of lesser periods)		
35	1. Check tanks for evidence of leakage at fittings and fuel duct connections. Also anchorage of fuel lines from each cell. Drain and check capacity. Inspect for deterioration and swelling.		
	300-HOUR INSPECTIONS		
	(Perform in addition to inspections of lesser periods)		
35	1. Fuel tanks: Inspect for signs of deterioration. This is accomplished by probing the bottom of each cell with a round wooden stick to see that the cells are solid and springy. If soft and spongy, cell should be removed for further check.		

Column No. Form 41B	Inspections Required	Symbols Denoting Condition	Remarks pertaining to defects replacements, etc.
	WEEKLY INSPECTION		
35	1. Visually inspect fuel cells where possible through fitting openings. Where raised or blistered areas, loose seams or other apparent defects are noted, the cell must be removed and repaired. Carefully examine all fitting nipples for possible damage. If fitting nipple shows evidence of chafing or cutting by hose clamps, tape nipple with suitable fabric, then replace clamrs.		
	SEMI-ANNUAL INSPECTION		
	Every six months, provided the cells have continuously contained gasoline, they should be inspected for signs of deterioration. One method used is to probe the bottom of the cells with a rounded stick of sufficient length. Another method is to aerate cell to complete internal dryness, then give it a weight test. (For detailed instructions, see T.O. 01-5EC-2 Section III, Page 92).		

Column No. ~~Form 41B~~	Inspections Required	Symbols Denoting Condition	Remarks pertaining to defects, replacements, etc.
	DE-ICER SYSTEM		
	PREFLIGHT		
	(To be performed prior to the first flight of the day.)		
10	Before Starting Engines 1. Check all de-icer shoes for punctures, loose patches, and other obvious defects, and for freedom from oil.		
	2. If, when the airplane is moored in the open with a high wind blowing, and the de-icer shoes seem to ripple and undulate, inspect at once and replace if necessary as a rippling or loose shoe might cause failure of the skin. CAUTION Do not drag heavy gasoline hose over the de-icer shoes or lean ladders or maintenance platforms against them.		
	3. Check operation of de-icer shoes for proper inflation (both wings and empennage) with the shop air supply as directed in handbooks. If these facilities are not available, make this check during first engine run-up of No. 1 or 2 engines. (T.O. 03-35B-1)		
	During Engine ~~Warm~~-up 4. Check de-icer system for proper operation and inflation. Check pressure gage - it should read approximately $7\frac{1}{2}$ to 8 p.s.i. pressure.		
	5. Check vacuum gage (3.75 to 4.25 in. Hg. with No. 1 and 2 engines running at 1000 r.p.m. or more). NOTE: The reading on the suction gage is the reading of only one pump's suction relief valve. The other pump's suction relief valve must be checked also. To do so, turn the handle of the vacuum selector valve (located on forward face of bulkhead 4.1 left hand side) to the other position.		

Column No. Form 41B	Inspections Required	Symbols Denoting Condition	Remarks pertaining to defect, replacement etc.
	AFTER FLIGHT		
30	1. Check for engine oil on de-icer shoes. Gasoline may be used to remove the oil, but it should be wiped dry at once with a clean, dry rag and not allowed to evaporate. Shoes may be washed with soap and water as part of the regular cleaning of the airplane. If rubber solvents are used for cleaning, rub shoes dry immediately.		
	CAUTION The black (prenite graphite) surface on the de-icer shoes should never be removed except for the purpose of applying a patch.		
	2. Check for punctures in shoes caused by static charges. Patch all punctures on both inner and outer sides of shoes.		
	DAILY		
	(To be performed at any time during the day)		
30	1. Check vacuum and pressure lines for tightness of joints, anchorage, and general condition.		
	2. Inspect de-icer shoes for proper attachment, loose patches, etc.		
	25-HOUR INSPECTIONS		
	(Perform preflight and daily inspections as usual in addition to this inspection).		
43	1. Check de-icing boot attaching screws for tightness. Check feed lines in both wings and tail for security and general condition. (T.O. 03-35B-1).		
	50-HOUR INSPECTION		
	(Perform preflight, daily and 25-hour inspections as usual in addition to this inspection.)		
	1. Check operation of de-icer system by connecting ground air supply into a "tee" plug in valve located in No. 1 engine nacelle. (A testing device capable of supplying at least the flow of air required to operate the de-icing system should be used.)		

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Column No. Form 41B	Inspections Required	Symbols Denoting Condition	Remarks pertaining to defects, replacements, etc.
	2. When the air supply has been connected, see that the check valves are not leaking, thus allowing air to blow back through the tubes to the instruments.		
	3. With system operating, check the pressure reading on pressure gage (should be 7½ to 8 lbs sq. in.). Ground inspection of the rubber parts should be made. If any parts inflate or deflate slowly, or if any gurgling is noted in the lines, such parts should be disconnected and the lines blown out under pressure. (It is important that inflation and deflation be rapid and complete as this is the governing factor in de-icer effectiveness.)		
	4. All sumps and drains should be opened and oil blown from the lines.		
	5. The surface of the rubber should be checked for any punctures.		
	6. Timing should be checked by timing several complete cycles. If a complete cycle takes more than 45 seconds electric timer and distributor valve should be checked to determine the difficulty. NOTE A slow operating cycle during the ground check may be due to an inadequate source of electrical supply to the distributor valve motor.		
43	7. Check tubing and electrical connections.		
	8. Check length of brushes of distributor valve motor. Brushes should be changed so that they will not be less than 13/32" long between inspection periods.		
	9. Check control valve attaching shafts for proper operation and ease of movement.		
44	10. Clean intake screen for the Gyro instruments.		
	100-HOUR INSPECTION		
	(Perform in addition to inspections of lesser periods.)		

Column No. Form 41B	Inspections Required	Symbols Denoting Condition	Remarks pertaining to defects, replacements, etc.
	1. Check vacuum pump for security of mounting. Check suction relief valve screens, and if dirty, remove screen, clean and replace.		
	2. Check all air lines for possible leaks.		
	3. Remove valve guide in safety valve which is in the line between exhaust side of pump and oil separator and wash in a suitable cleaning fluid. If valve disk is worn, dress it with a flat oil stone. Test spring tension (when compressed to 1 1/8 in., tension must be 3.7 lbs.)		
	4. Clean Pesco oil separator by removing oil outlet fitting, removing screen and cleaning in a suitable cleaning solution. Dry with compressed air and re-install. (T.O.03-30AA-1).		
44	5. The vacuum supply to vacuum operated instruments will be checked at each instrument to insure correct functioning.		
	6. After removing Bank and Turn indicator and draining and cleaning it, reinstall instrument and test the vacuum to it. Vacuum should be 1.80 to 2.05 inches Hg. with engine operating at normal cruising r.p.m. (See T.O. 01-5EC-2 Section IV. Page 305 for the procedure for adjusting restriction valve for the bank and Turn indicator.)		
	300-HOUR INSPECTION		
	(Perform in addition to inspections of lesser periods)		
	1. Disassemble Eclipse Oil Separator and wash in gasoline.		
	ENGINE CHANGE OR MAJOR OVERHAUL		
	1. Replace vacuum pump unless overhauled within 100 hours previously.		
	2. Remove distributor valve and control valve and forward to an authorized service station overhaul base, or to manufacturer. This procedure constitutes a complete disassembly of the unit and involves the use of special tools and equipment available only at above mentioned places.		

Column No. Form 41B	Inspections Required	Symbols Denoting Condition	Remarks pertaining to defects, replacements, etc.
	OXYGEN SYSTEM		
	PREFLIGHT		
	(To be performed prior to first flight of the day)		
	CAUTION		
	Due to danger of combustion, extreme caution must be used when handling oxygen equipment. Keep the oxygen system clean and free from oil and grease. Be sure hands and clothes are free from oil.		
10	1. Make a usual inspection of all oxygen lines. Replace damaged lines prior to flight.		
	2. Check all parts of the mask to see if it is in good shape and ready for instant use. The mask must be clean. Try it on in the airplane and check for leaks by holding the thumb over the quick-disconnect fitting and inhaling normally.		
	3. Be sure that the rubber gasket is in place on the male quick-disconnect fitting.		
	4. Be sure the male quick-disconnect fits snugly in the female connection of the hose from the regulator at your station and at any other station you may use as well as in the portable units. A pull of about 10 lbs. should be required to separate the two. If it does not fit tightly, pry open the prongs on the male fitting with a knife blade until the required adjustment is made.		
	5. Inspect the hose from the regulator for any damages such as tears, holes and kinks. Be sure all clamps are firmly in place.		
	6. Clip oxygen supply hose by means of its spring clip onto the clothing or parachute close enough to the face to permit free head movement without kinking or pulling off the corrugated mask hose.		
	7. Be sure the knurled coller at the outlet elbow of the regulator is tight so that the elbow does not turn.		

Column No. Form 41B	Inspection Required	Symbols Denoting Condition	Remarks pertaining to defects, replacements, etc.
	8. Examine the regulator for any damage, particularly see that the diaphragm is not ruptured or distorted.		
10	9. Check emergency valve or regulator by opening it and seeing if you get a large flow. Never block the outlet of the hose when the emergency valve is open, otherwise the regulator may be damaged and the diaphragm blow out. Turn off the emergency valve firmly.		
	10. Check the operation of the flow indicator by turning the Auto-Mix to the "off" position and breathe normally through the regulator. Then turn the Auto-Mix to the "on" position.		
	11. Check the pressure gage at each station. Pressure should be 400 p.s.i. The manufacturing tolerance on the accuracy of the gages is such that there may be an appreciable difference in the pressure reading, even though the pressure is actually the same for all.		
	12. Charge all oxygen systems with grade A, dried oxygen, Specification No. AN-O-1a (For instructions on charging the system see T.O. 01-5EC-2, Section III, P. 34: also instructions on charging cart itself.)		
	13. Check pressure in walk-around bottles. It should be 400 p.s.i.		
	14. Bail-out or emergency equipment should be filled to 1800 p.s.i. and ready for instant use.		
	AFTER FLIGHT		
30	1. Keep mask in clean, sanitary condition by frequent washing.		
	2. Change strap adjustment only to take up natural stretch slack.		
	3. Be sure before leaving airplane that all oxygen equipment is in proper condition. If difficulties have developed during flight, take necessary steps to have them corrected.		

Column No. Form 41B	Inspections Required	Symbols Denoting Condition	Remarks pertaining to defects, replacements, etc.
	4. Refill oxygen system if it does not contain sufficient pressure for another mission.		
	25-HOUR INSPECTIONS		
	(Perform preflight and daily inspections as usual in addition to this inspection)		
41	1. Inspect the oxygen cylinders, regulators, tubing, and flexible lines for security of mounting. Check the distribution and supply system for leaks, evidence of corrosion, dented or buckled tubing and loose clamps or connections.		
	SPECIAL INSPECTIONS		
41	1. Oxygen flow indicator for operation (See T.O. 01-5EC-2, Section III, page 101 for procedure.)		

Column No. Form 41B	Inspection Required	Symbols Denoting Condition	Remarks pertaining to defects, replacements etc.
	HEATING SYSTEM		
	PREFLIGHT		
	(To be performed prior to the first flight of the day).		
10	1. Inspect Stewart-Warner heaters for security of mounting. Clean and tighten any loose connections.		
	2. Check operation of all six heaters by turning on all three switches. Master switch and Co-Pilot's switch on Co-Pilot's auxiliary panel and Bombardier's switch on bombardier's switch panel.		
	3. Check "Clicking" of heater relay below Co-Pilot's auxiliary panel in nose wheel compartment.		
	4. Check for operation of each heater to determine air circulation.		
	5. Apply finger cautiously to the igniter at back of casting of each heater. Be sure igniter is hot.		
	6. Check manually operated shut-off valve to insure that they are in open position so as to permit fuel air mixture to reach heaters.		
	CAUTION After checking heaters, see that Master Heater Switch at Co-Pilot's panel and heater group switches at Bombardier's and Co-Pilot's panel are in "Off" position, so that heaters will not be operating during take-off.		
	25-HOUR INSPECTION		
	No inspection.		
	50-HOUR INSPECTION		
	(Perform preflight, daily and 25 hour inspection as usual in addition to this inspection.)		
43	1. Check fuel-air mixture lines and exhaust lines for condition and tightness of plumbing.		

Column No. 41B	Inspections Required	Symbols Denoting Condition	Remarks pertaining to defects replacements, etc.
	2. Test the igniter to see if it shuts off in 2 to 5 minutes after the heater system is turned on. (Refer to T.O. 01-5EC-2, Section III, P.103, for procedure for testing the igniter.)		
	3. Remove flame arrestor and check for lead accumulation. Clean before re-installing.		
	4. Remove restriction fitting and check for lead accumulation. If necessary, clean the fitting, making certain not to enlarge the restriction opening.		
	5. Check the solenoid valves for opening which causes a "clicking" sound. To test the solenoid valve in this manner it is necessary to remove the engine cowling over the engine accessory compartment. (For procedure in checking see T.O. 01-5EC-2 Section III, P. 103 and 104).		
	6. Check manual shut-off valve. It should be open.		
	7. Check all electrical connections and check heaters for security of mounting. (See T.O. 01-5EC-2 Section III, P. 102-104).		
	100-HOUR INSPECTION		
	Same as 50 Hour Inspection		
	200-HOUR INSPECTION		
	(Perform in addition to inspections of lesser periods)		
43	1. Remove heaters and overhaul; replace heaters after overhauling and repeat 50 hr. Inspection.		

Column No. Form 41B	Inspections Required	Symbols Denoting Condition	Remarks pertaining to defects, replacements, etc.
	ANTI-ICER SYSTEM		
	PREFLIGHT		
	(To be performed prior to the first flight of the day)		
	Before Starting Engine		
10	1. Check fluid level in Anti-Icing tank. Fill with Fluid, Spec. AN-F-13.		
	2. Check to see if Anti-Icer system functions properly.		
	AFTER FLIGHT		
19	1. Check fluid tank gage for sufficient fluid for the next flight.		
	DAILY INSPECTION		
	No inspection.		
	25-HOUR INSPECTION		
	No inspection.		
	50-HOUR INSPECTION		
	(Perform preflight, daily and 25 Hour Inspection as usual in addition to this inspection.)		
43	1. Check tubing, wiring connections and braces.		
28	2. Check propeller anti-icing pump and motor for security of mounting and for leakage in the system.		

Column No. Form 41B	Inspection Required	Symbols Denoting Condition	Remarks pertaining to defects, replacements, etc.
	VENTILATION		
	PREFLIGHT		
	No inspection		
	DAILY		
	(To be performed at any time during the day)		
30	1. Inspect ventilating air ducts for cracks, air leaks and obstructions.		
	2. Check air intake at pitot tube against obstructions.		
	25-HOUR INSPECTION		
	(Perform preflight and daily inspections as usual in addition to this inspection.)		
31	1. Inspect ventilating air ducts for cracks, air leaks and obstructions.		
	2. Check air intake at pitot tube against obstructions.		
	50-HOUR INSPECTION		
	(Perform preflight, daily and 25 hour inspections as usual in addition to this inspection.)		
31	1. Check for condition and obstructions at air intake screen in leading edge of right wing.		

+ to —

Airplane & Engine Mech Course (Special B-24)
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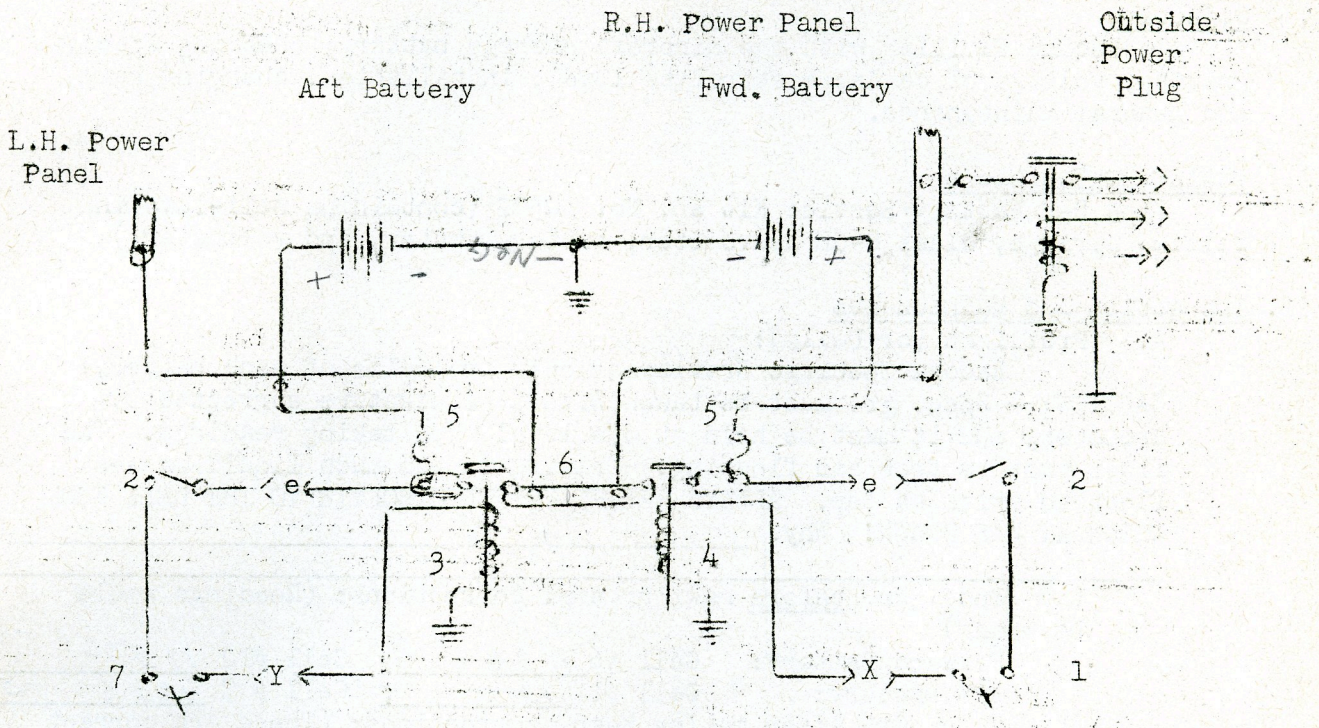
BATTERY SOLENOID-RELAY SWITCHES

Purpose: To "point check" the circuit and become familiar with location and operation of equipment. (See P-3 drawing in "Circuit Wiring Diagram".)



Number in Drawing	Name of Part	Station Location
#3	Solenoid (aft battery)	Sta 3.2 L.H.S.
~~#4~~ ~~#7~~ #1	Manual switch (forward battery)	a Pilots side of Flight Deck
#4	Solenoid (forward battery)	Sta 31 L.H.S
#7	Manual switch (aft battery)	a Pilots side of Flight Deck
#2	Master switch (Crash Bar)	
#5	Fuses	
#6	Battery Positive Bus	

BATTERY VOLTAGE CHECK:

Close the master switch (Crash Bar) & disconnect "Outside Power Plug"

(a) With only Forward Battery Disconnect Switch closed, _____ volts.
(b) With only Aft Battery Disconnect Switch closed, _____ volts.
(c) With Forward & Aft Battery Disconnect Switches "open" and "Outside Power Plug" connected, _____ volts.

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BATTERIES

Reference: Technical Order 03-5B-1

I. Objective

To become familiar with the aircraft storage battery; checking specific gravity, voltage of cells, electrolyte level, installation, charging rate, and general maintenance.

II. Tools and Equipment

Type D-1 Battery Service Kit sp. No. 40572 (containing self-leveling filling syringe, class 0-5B hydrometer, battery water, and voltmeter.)

III. Inspection and Maintenance

A. Preflight (or Daily):

Record Specific Gravity of only two cells of each battery:

CAUTION: - Spec. gr. must be taken with a temperature corrected hydrometer, and it must be held at eye level when taking readings. The float must be free and floating. Drawing in too much liquid causes float to stick at top. ALWAYS RETURN THE ELECTROLYTE TO THE CELL FROM WHICH IT WAS DRAWN! Why? _____

(a) Spec. gr. before making temp. corrections: (Readings would be wrong)

Forward Battery: Cell #6 1160 -4; Cell #12 1150 -4
Aft Battery: Cell #1 1250 -5 Cell # 7 1260 -5

(b) Spec. Gr. after making temp. corrections: (These are correct readings.)

Forward Battery: Cell #6 1156 Cell #12 1146
Aft Battery: Cell #1 1245 Cell # 7 1255

Battery Replacement:

A battery should be replaced if its Sp. gr. is below 1,240 or above 1,310, or if any two cells differ by more than 20 points.

CAUTION: - See your Instructor before removing battery if it is below standard: A BATTERY IS ONE-THIRD DISCHARGED IF ITS SPECIFIC GRAVITY IS JUST BELOW 1.240.

Maintenance:

If hydrometer reading can be taken of a battery, it does not need water. If not, distilled water or clean drinkable water should be added to 3/8" above the plates. Use self-leveling syringe and withdraw all excess water. ALWAYS HOID SYRINGE STRAIGHT UP AND DOWN. If water is added in freezing weather, battery should be charged immediately.

Why? Prevent freezing

Why should battery leads be checked for corrosion daily? Keep resistance at a minimum

How would you treat corroded leads and terminals? wash with soda water & grease

Why should the vents be checked daily for open condition? Prevent blowing up (Hydrogen gas forms)

Felt pads in battery vent spaces should be kept saturated with sodium bicarbonate. Avoid having excess on top of battery. Battery sump jars should be kept filled up to felt pads with a concentrated solution of sodium bicarbonate made by adding as much sodium bicarbonate to water, at room temperaturs, as it will dissolve.

BATTERIES (continued)

B. 25-Hour (or weekly, whichever comes first):

1. Check condition of all battery cells with hydrometer proceeding from positive to negative. Record below cell No. and on line to right of Sp. gr.

	Gravity Check	1	2	3	4	5	6	7	8	9	10	11	12
Satis-)	1.275 - 1.310												
factory)	1.240 - 1.275												
*)	1.225 - 1.240												
See *)	1.200 - 1.225												
foot- *)	1.175 - 1.200												
note *)	1.150 - 1.175												

Water Level - Should be 3/8" over plates

Inspect battery leads for condition of insulation. _____

Inspect & Tighten battery terminals _____
(Order is: the lead, lockwasher, plain washer, and wing nut)

Remove and replace corroded washers, wing nuts, etc. _____

Check mounting bolts: - Must be snug enough to hold battery in position, but not so tight as to warp or crack the case. _____

Are battery cases or the sealing compound cracked? _____

All Preflight & Daily Inspections should be repeated.

C. 50-Hour Inspection:

Repeat the 25-Hour Inspection and the Preflight (Daily)

* Need for charging indicated. Remove to be charged and replace with charged battery.

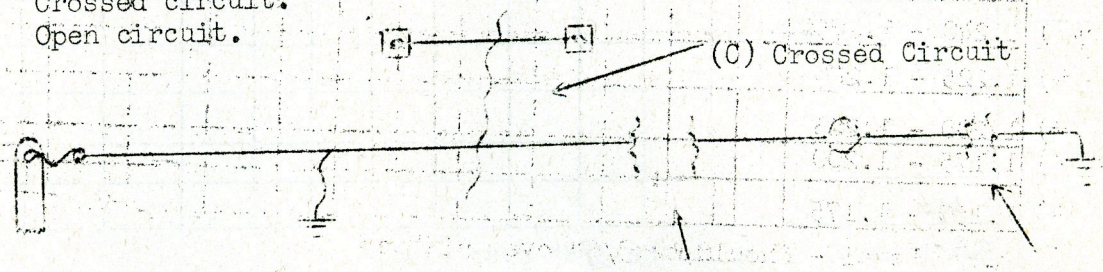
TROUBLE SHOOTING TECHNIQUES

TITLE: Trouble Shooting Technique with Test Light or 30-Volt range voltmeter.

TOOLS: 28 Volt test light, or voltmeter (30 volt), 3/8" 6 pt. socket wrench with "T" handle.

GENERAL INFORMATION: Faults in electrical circuits may be classified as follows:

1. Faulty fuse.
2. Grounded or short circuit.
3. Crossed circuit.
4. Open circuit.



(a) Open fuse (b) Ground (d) Open circuit (e) Open ground

Any one of these faults will cause failure in the operation of an electrical circuit.

PROCEDURE:

Step I. Check for the operation of the unit; motor, light or solenoid being tested. In case of failure to operate, proceed to Step 2.

2. Check for "hot" bus. Use test light with leads attached from bus to "ground" or fuse box. A light will indicate a "hot" bus.

3. Check for good fuse. Test on each end of the inserted fuse to "ground". A light in each case will indicate a good fuse and a satisfactory contact. Failure to show a light on the circuit end of the fuse will indicate a "burned out" fuse.
CAUTION: When a fuse indicates that it is burned out, it should not be immediately replaced, but the circuit should be checked for "ground" as in Step 4.

4. Check for ground in a circuit: Use the test light as a fuse by placing it in series with the circuit being tested. (Clip the test leads on the fuse contacts) Disconnect the circuit load as close to motor or lamp as possible and close the circuit switch. A "ground" in the circuit will light the test light. To determine the location of the "ground", disconnect each section of wire of the circuit separately, at the Q-strips and cannon plugs, beginning removal at the load end of the circuit. The section removed that causes the test light to go out is the faulty section.

PHASE III
ELEC. CIRCUIT 100

Job Sheet
III-4

Airplane & Engine Mech Course (Special B-24)
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FUEL TRANSFER PUMP CIRCUIT AND FUEL BOOSTER CIRCUIT

Reference: 01-5EC-2

I. Objective

To practice tracing circuit from "schematic book".

II. Procedure

Trace circuit and fill in wire numbers, harness numbers, "Q" strip station location and terminal numbers counting from top to bottom on perpendicular strips and from left to right on horizontal strips, and identify cannon plug terminals by letter or number (from Schematic).

FUEL BOOSTER PUMPS (Four in number-Trace one

Co-Pilot's
Fuse Box

AUXILIARY FUEL TRANSFER PUMP

Pilot's
Fuse Box

III. Inspection Preflight: Check operation of above motors.
50-Hour: Check solidarity of wiring.

NOTE: KEEP THE SPARE FUSE BLOCK FULL AT ALL TIMES ! ! ! !

Job Sheet
III-5

PHASE III
ELEC. CIRCUIT 100

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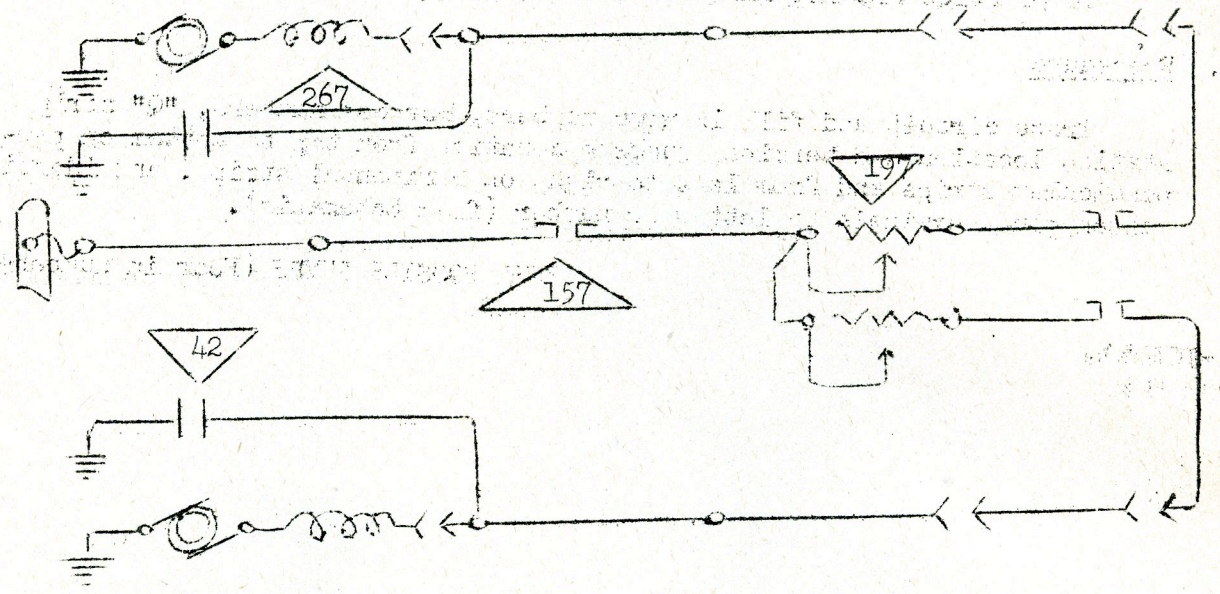
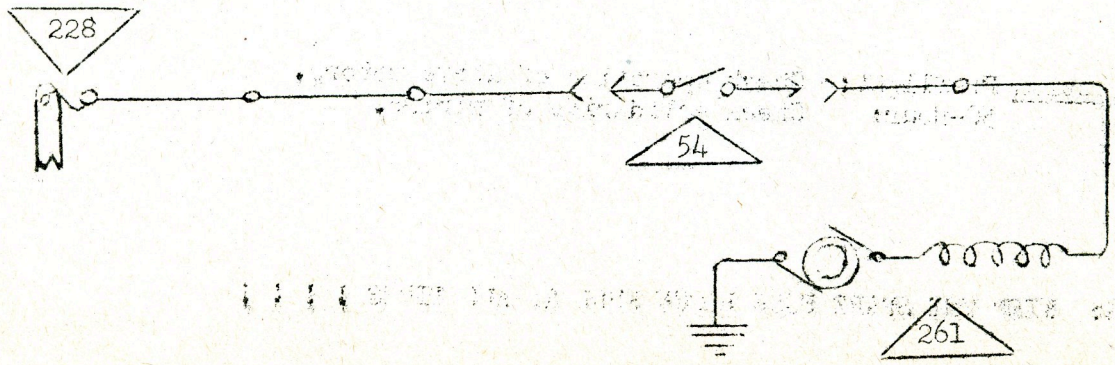
Reference: T.O. 01-5EC-2

PROCEDURE: Locate and identify by station location numbers all check points and wire numbers from Schematic Book and fill in the information on the circuit below. Identify triangles and check circuit on ship.



DE-ICER MOTOR CIRCUIT

PROCEDURE: Locate and identify by station location numbers all check points and wire numbers from Schematic Book and fill in the information on the circuit below. Identify equipment by numbers in triangles by using last pages of "Schematic Wiring Diagram" book. Check circuit on the ship.



FLUORESCENT LIGHT CIRCUIT

Reference: Circuit Wiring Diagrams Print V-5

PROCEDURE: Copy wiring diagram of Flourescent Lights paying particular attention to the light receptacle and rheostat switch drawing in lower right hand corner of wiring print.

If the voltage at the fuse is 28 volts Direct Current and if this voltage must pass through a current limiting resistor before being used by the light, would a voltmeter check of a Flourescent Light bulb filament circuit show a voltage of 28 volts or less than 28 volts? _____.

Normal check of a Flourescent Light bulb that is suspected of being burned out is to check it by exchanging it with a light that operates.

If a light bulb were checked outside of the receptacle by using 28 volts-----what would happen to the light bulb? _____.

Check fluorescent lights and make report on the condition of the lights.

SOLENOIDS AND RELAYS

Reference: Circuit Wiring Diagrams, Print P-4.

PROCEDURE: This print is about the External Power Plug solenoid switch. Check with the ship for operation and connection.

Draw a simple circuit using a solenoid switch to operate a motor.

Consult Prints S-1 and S-2 for examples.

BLUE FORMATION LIGHTS

Reference: Circuit Wiring Diagrams, Print E-3

PROCEDURE: Copy wiring diagram from the Circuit Wiring Diagram book. Check the circuit on the ship and make notation on the drawing of points checked and station location of all points. List all missing or defective parts.

RUNNING AND PASSING LIGHTS

Reference: Circuit Wiring Diagrams, Prints E-2 and E-4

PROCEDURE: Copy wiring diagrams from the Circuit Wiring Diagram book. Check the circuits for operation and list all defective or missing parts of circuit.

RECOGNITION LIGHTS

Reference: Circuit Wiring Diagrams, Print L-1.

PROCEDURE: Copy wiring diagram from the Circuit Wiring Diagram book. Check lights for operation in "steady" and "keying" positions. List station location of all points of circuit on your wiring diagram. Make list of all defective or missing parts.

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ALARM BELLS CIRCUIT

I. Title

To "Point Check" the alarm bells circuit.

II. Purpose

To become familiar with the method of checking an electrical circuit with a minimum of time, giving special emphasis to "checking" quickly accessible points on the airplane for circuit checking, avoid using cannon plugs as check points.

III. Procedure

Using your schematic drawings, re-draw the circuit and "point check" the circuit. Have your instructor check the "pointing" you made. Then trouble shoot the circuit. Instructions on trouble shooting are located in previous pages, listed "Trouble Shooting Techniques".

IV. Preflight Inspection: Check for operation of the alarm bells.

V. 50-Hour Inspection: Check for operation and condition of wiring. A blown fuse indicates a temporary overload or a serious defect. Make a thorough check of such equipment. Refer to "Trouble Shooting Techniques".

NOTE: KEEP THE SPARE FUSE BLOCK FULL AT ALL TIMES.

FUSE FAMILIARIZATION (Part One)

I. Instructions

Locate the following fuse boxes, giving the name of the compartment, the Side of the ship, and the number of fuses in each box:

Name of Fuse Box	Compartment	Side of Ship	Source of Power
Bombardier's Fuse Box	Bomb Comp. L.H.S.	Left	Battery Bus
Pilot's Fuse Box	Flight Deck	Left	" "
Co-Pilot's Fuse Box	" "	Right	RH Pannel
Sta. 5.2 Fuse Box	Comm Deck	Left	LH Pannel
Sta. 8.0 Fuse Box	Rear Comp	Right	RH Pannel
Bomb Bay Fuse Box	Bombay 4.0	R.	" "
Left Hand Power Panel	4.2 Bomb Bay	L	Battery Fuse Box
Inverter Relay Junction Box	Nose Wheel 4.0	L	Battery Bus Bar
Tail Turret Switch Box	Tail Comp	R.H.S.	RH P Pannel
Landing Light Relay Box	Wheel well	Both	RH P Pannel " Pannel
Reverse Current Relay Box	" "	"	Battery +
Battery Fuse Panel	Nose Wheel	L	Battery
Heater Fuse Box	Bomb Comp	R	RH Pannel
Ball Turret Switch Box	Rear Comp	R	RH Pannel
Sta. 7.7 Fuse Box	Rear Comp	Left	LH Pannel

1. Turn on Sw.
O.K. 2. Check Fuse - burned out, short
3.
3. Open circuit | 4. Short
5. Open Grnd.

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FUSE FAMILIARIZATION (Part Two)

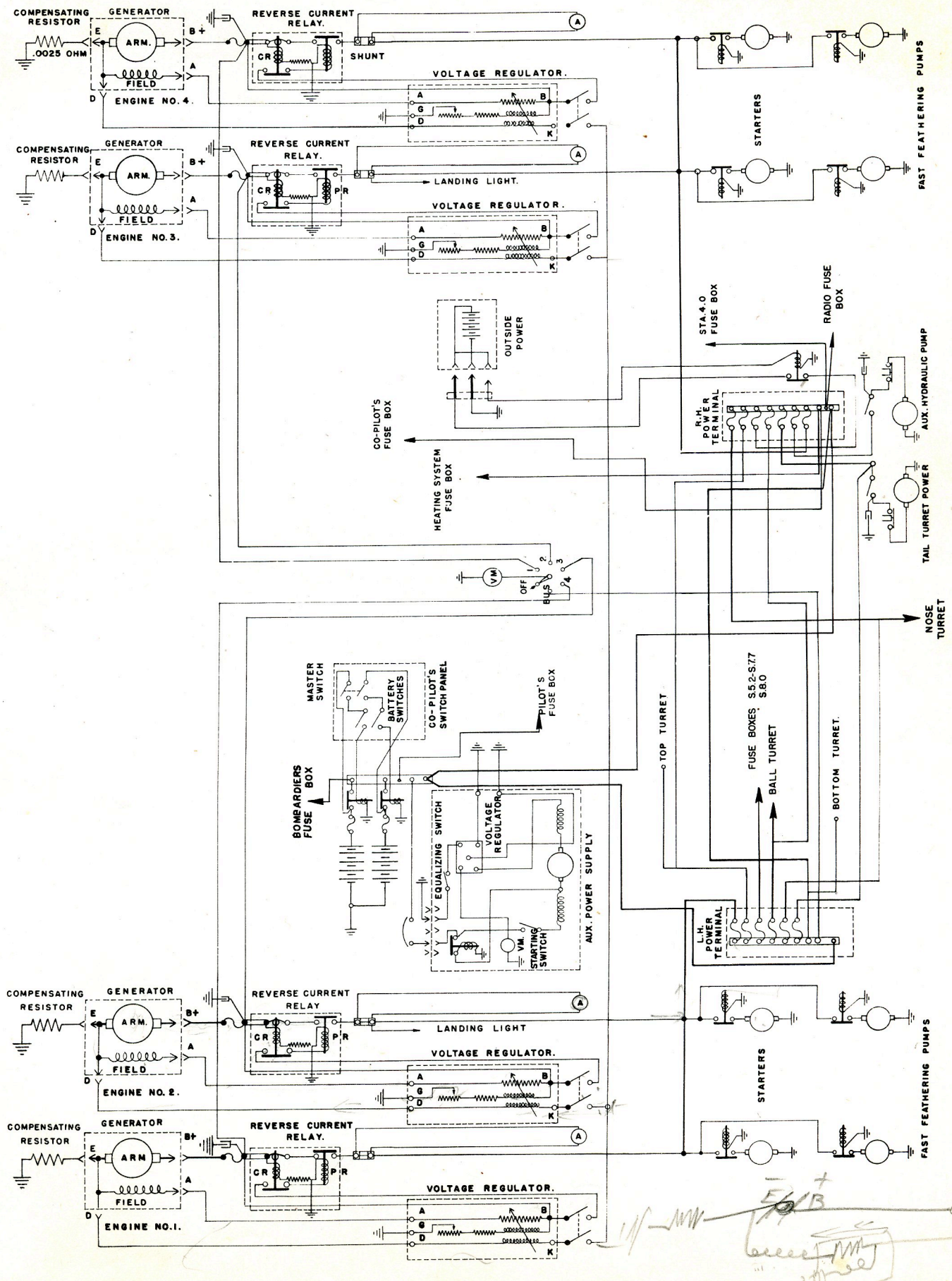
II. Instructions

Locate fuses for the following circuits, giving the name of the fuse box, the compartment in which it is located, and the size of the fuse:

Circuit	Name of Fuse Box	Compartment	Size of Fuse
Formation, running and passing lights	Pilots Fuse Box ~~Flight Deck~~	Flight Deck	15
De-Icer Motor	40 Fuse Box	Bombay R.H.	10
Prop Governor #4 Engine	Pilots Fuse Box	Flight Deck	10
Bomb Station Lights	Co Pilots	Flight	5
Bomb Door Indicator Lights	40 Fuse Box	Bomb Bay	10
Bomb Release Switch	Bomb Fuse Box	Bomb Comp	2
Oil Dilution Solenoids	Co-Pilots	Flight Deck	10
Intercooler Shutter Motors	" "	" "	20
Nose & Tail Alarm Bell Switch	Pilots Fuse Box	Flight Deck	10
Recognition Lights	" " "	" "	10
D.C. Fluorescent Lights, C 4 & C 5	Co-Pilots	" "	5
Upper Turret Heater	Heater Fuse Box	Bomb Comp	15
A. C. Relay Switch	Co Pilots	Flight Deck	5
Start and Mesh Switches	" "	" "	20
Heater Solenoid Engine #2	Heater	Bombardier	10
Ball Turret & Landing Gear Down Indicator Light	Ball turret 60 R.H.	Rear	2

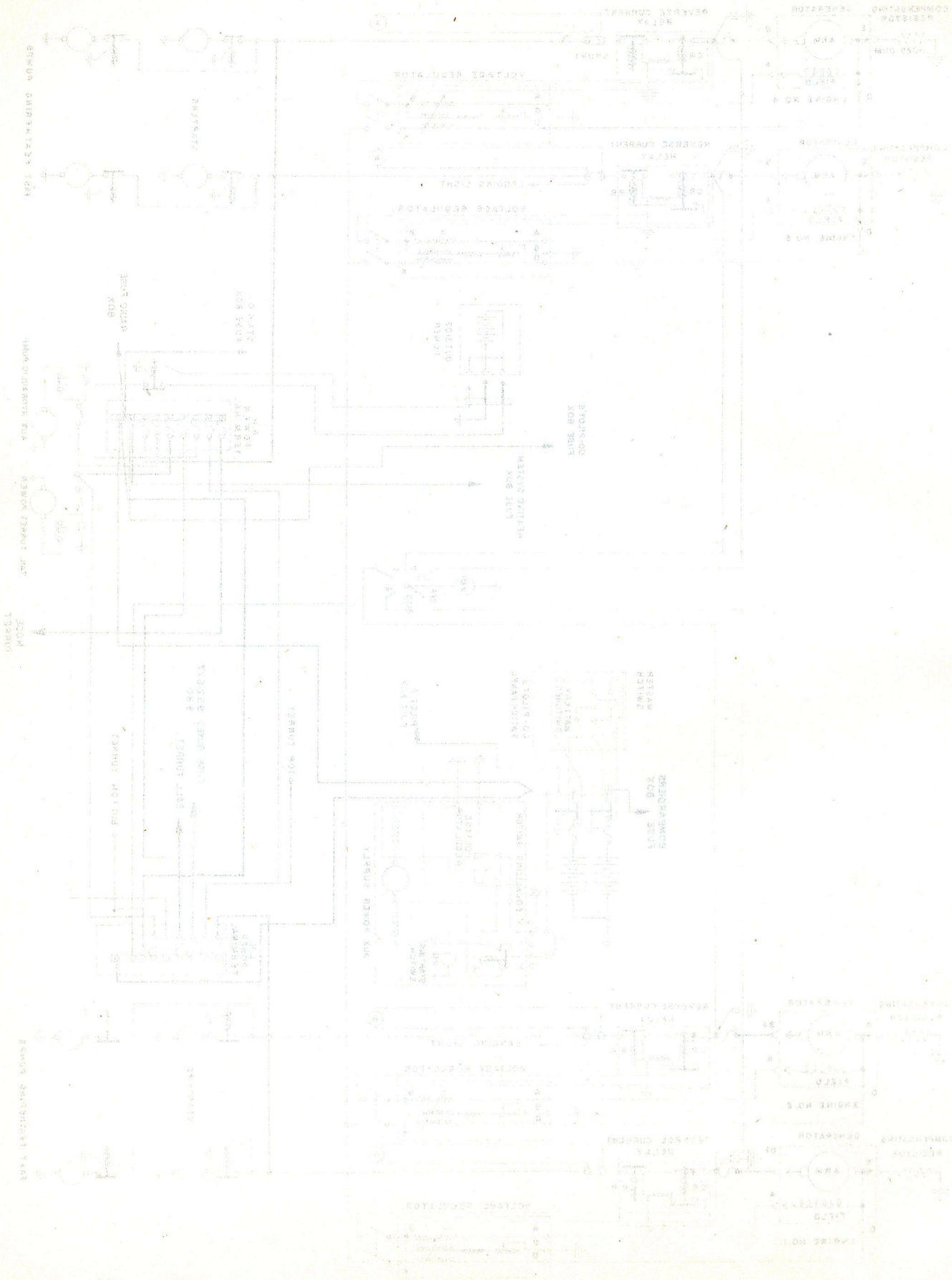
AIRPLANE & ENGINE MECHANIC COURSE (SPECIAL B-24)

FORD AIRPLANE SCHOOL



POWER CIRCUIT

RESTRICTED



Job Sheet
III-9

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

PHASE III
ELEC. CIRCUIT 200
(ENGINE)

GENERATORS.

Reference: Technical Orders 03-5AF-1, 2 03-5-39 and 03-5EC-2

I. Type: P-1, capacity 200 amperes at 28.5 volts and 2500 Engine r.p.m.

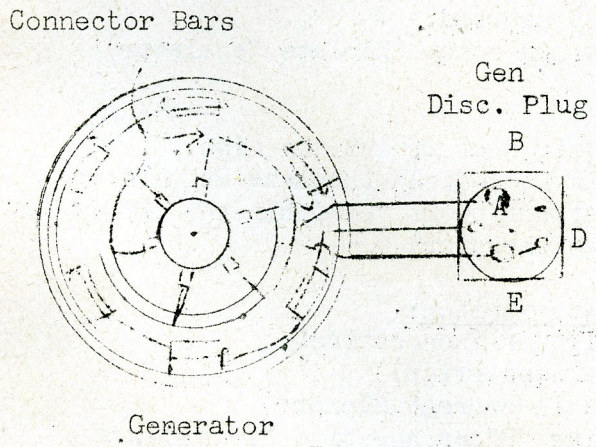
II. Use: To furnish D.C. power for all the D.C. electrical equipment on the ship during flight.

III. Tools and Equipment: Ohmmeter, screw-driver, ½" rule, and a spring balance or tensionmeter.

IV. Preliminary Instructions: Two men work together. Be sure to keep ohmmeter test leads away from hot circuits whether they be A.C. or D.C. source. Do not disassemble the generator. Do not remove brush end from assembly. The generator bearings are of the packed and sealed type, therefore the generator needs no lubrication between engine change. The generator is not to be disassembled any further than as stated below. See Instructor before removing any brush.

V. Procedure: Disconnect generator line at generator disconnect, or at firewall disconnect plug. Make the checks indicated below; using the Ohmmeter, for condition of generator internal circuits.

The following circuit may be used as an aid to electrical checking.



"A" is the field terminal.
"B" is the plus lead.
"E" is the negative lead.
"D" is connected to "E" by a shunt connection and is the negative field terminal

Field test.
A to E 2.2 – 2.5
Armature test
B to E .5 – 1.
Jumper test.
D to E Cont only, unless shorted
Grounded Generator.
A, B, E, D are individually tested with ground of generator. (Iron structure.)
Results: _____

Type	Minimum brush length.	Brush spring tension.	Field resistance.	Armature R.
Delco-Remy Shunt wound	Remove when top of brush is 3/8 inch above slot in brush holder.	35 - 47 ounces. (Test with fingers.)	2.6 - 2.75 Ohms	0 - 1.0 Ohm resistance for all generators. Excessive resistance shows poor condition of armature and brushes.
Westinghouse Compound wound.	Remove when top of brush is 1/16 inch below brush holder.	24 ounces. (Use wire hook to lift the Spring or use fingers.)	Test for continuity and grounded fields.	
General Electric or Ford. Shunt wound	Remove when top of brush is 1/4 inch above brush holder	14 to 18 ounces. (Use wire hook to lift the Spring or use fingers.)	1.9 to 2.2 Ohms	

ALTERNATE GENERATOR CHECK

The generator may be checked from the regulator panel with the regulator removed. Check as follows: A to G _____ ohms, B to G _____ ohms, D to G _____ ohms. Compare the results with the readings obtained from the generator circuit directly. The results from this check will be $\frac{1}{2}$ to $1\frac{1}{2}$ ohms higher than those obtained on page 27. Why? _____

GENERATOR TROUBLES

Generator Produces No Voltage:

1. Voltmeter Lead broken or inoperative voltmeter
2. Generator field should be "flashed" by removing Regulator and putting "hot" lead on terminal "A" of Regulator Base.
3. Generator should be replaced if voltage check at generator terminals shows no voltage output. (Broken drive shaft, etc.)

Generator Produces about 2 volts Residual Voltage.

1. Voltage regulator does not allow enough current to go to field of generator to "build up" voltage. (Replace Voltage Regulator)
2. Generator field circuit is "open". Replace generator.
3. Field lead to regulator "A" terminal is open.

Generator Produces Low Voltage

1. Generator armature or field is partially shorted.
2. Voltage Regulator resistor is open at a mid point (Replace Regulator)

Generator Produces High Voltage:

1. Regulator is inoperative, causing full field or is set too high.
2. Regulator coil or circuit is open giving full field (Replace Regulator).
3. Field lead in generator shorted to generator positive within the generator at connector, in wiring system (Replace Generator)

Generator delivers No Current with Closed Generator Switch:

1. Reverse Current Relay setting is too high or inoperative.
2. Reversed connections at generator (Polarizes relay)
3. Reverse Field in generator (Flash field in correct manner)
4. Generator circuit open on either positive "B" or negative "E" side.
5. Slow burning fuse open (200 AMP in Reverse Current Relay Box.)
6. Ammeter leads broken or inoperative ammeter.

Engineer turns A.P.U. and Auxiliary Hydraulic Unit "off" at take-off. Pilot may "take-off" with either generator power or battery power. If generator power is used, or if batteries are low, the engineer turns on generator switches when engine r.p.m. is over 1800 r.p.m.

The voltage output of the generators is controlled by what electrical accessory? _____

What electrical accessory is operated by the generator switch? _____

VOLTAGE REGULATORS

Name _____ Ser. No. _____ Group _____ Date _____

References: 03-5-42 and _____

I. Type & Purpose:

The B-24 is equipped with either the Eclipse or the Delco-Remy carbon-pile type of voltage regulators.

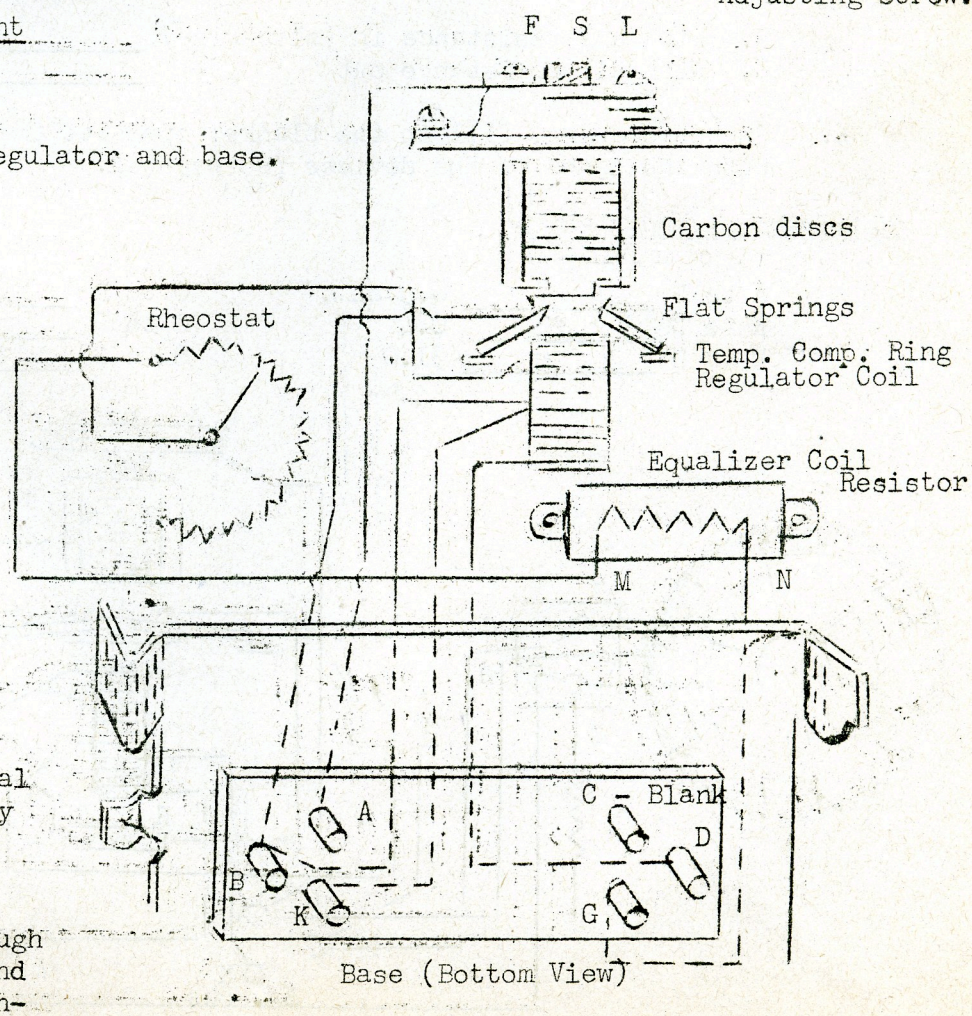
The purpose of the generator regulator is to maintain constant output voltage of the generator at normal operating speeds regardless of the load when below 200 amps. per generator.

II. Preliminary Instructions.

Defects which may occur to the regulator are improper adjustment of the resistance of the carbon pile and of the variable resistance under the knurled nut. Other defects would be OPENS, SHORTS, or GROUNDS in the coils and resistance. The combination Pictorial-Schematic diagram below will assist you in making your diagnosis of any trouble in this device. Do not disassemble the regulator.

III. Tools and Equipment

1. Ohmmeter
2. Carbon pile regulator and base.



The adjacent sketch shows the internal wiring of the Delco-Remy Voltage Regulator.

The Regulator on the following page shows the circuits through the Eclipse Regulator and their connections to generator.

VOLTAGE REGULATORS (Continued)

IV. Procedure

Make the following Ohmmeter checks of the voltage regulator and record the results. (Do not disassemble the regulator, and do not turn adjusting screw at top of carbon pile or below coil housing.

1. Continuity of Ohms: The values given are the Delco-Remy-Regulator

A to B _____	(Cold---0.9 ohm.)	M to N _____	(Approximately 30)
	(Hot----3.5 ohm.)	O to P _____	(Range 0 to 12)
B to G _____	(50 to 65)	O to B _____	(approximately 20)
K to D _____	(.36 to .44)		

2. The following should check open circuit.

A to K _____	A to D _____
B to K _____	B to D _____
G to K _____	G to D _____

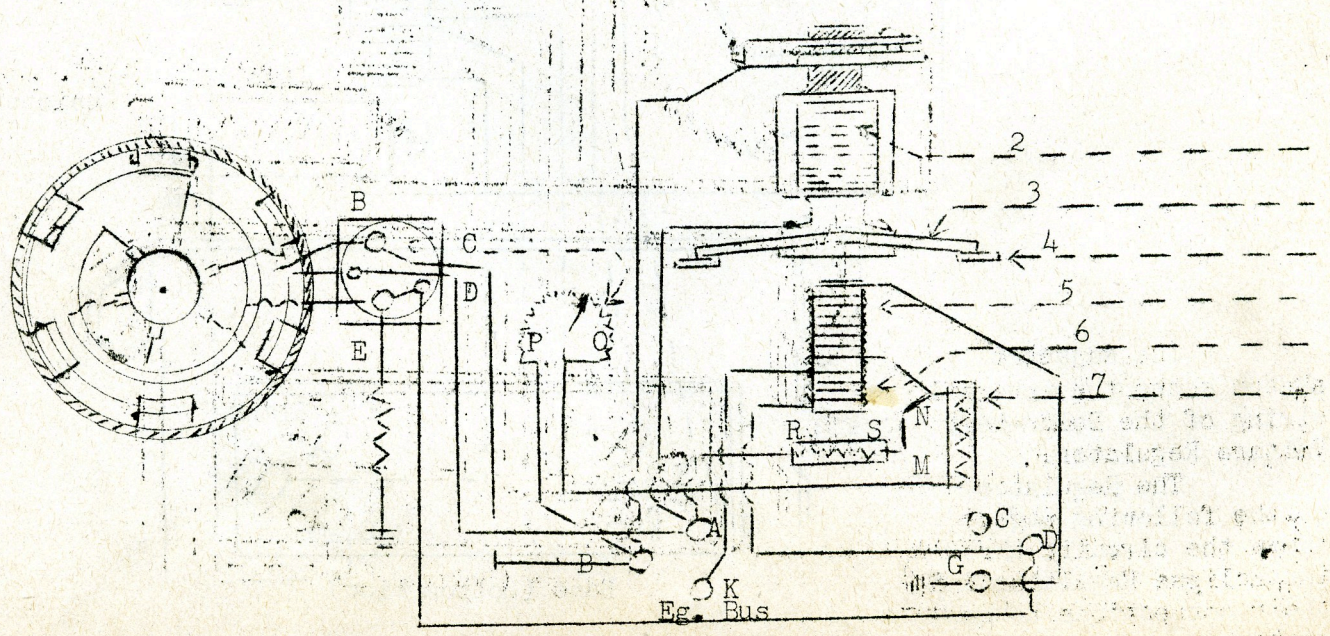
3. Check the operation of the regulator coil rheostat by measuring ohms from B to G:

   a. With all resistance in (clockwise) _____
   b. With all resistance out _____

4. In the drawing, fill in the blanks, opposite the circled numbers, with the names of the devices represented.

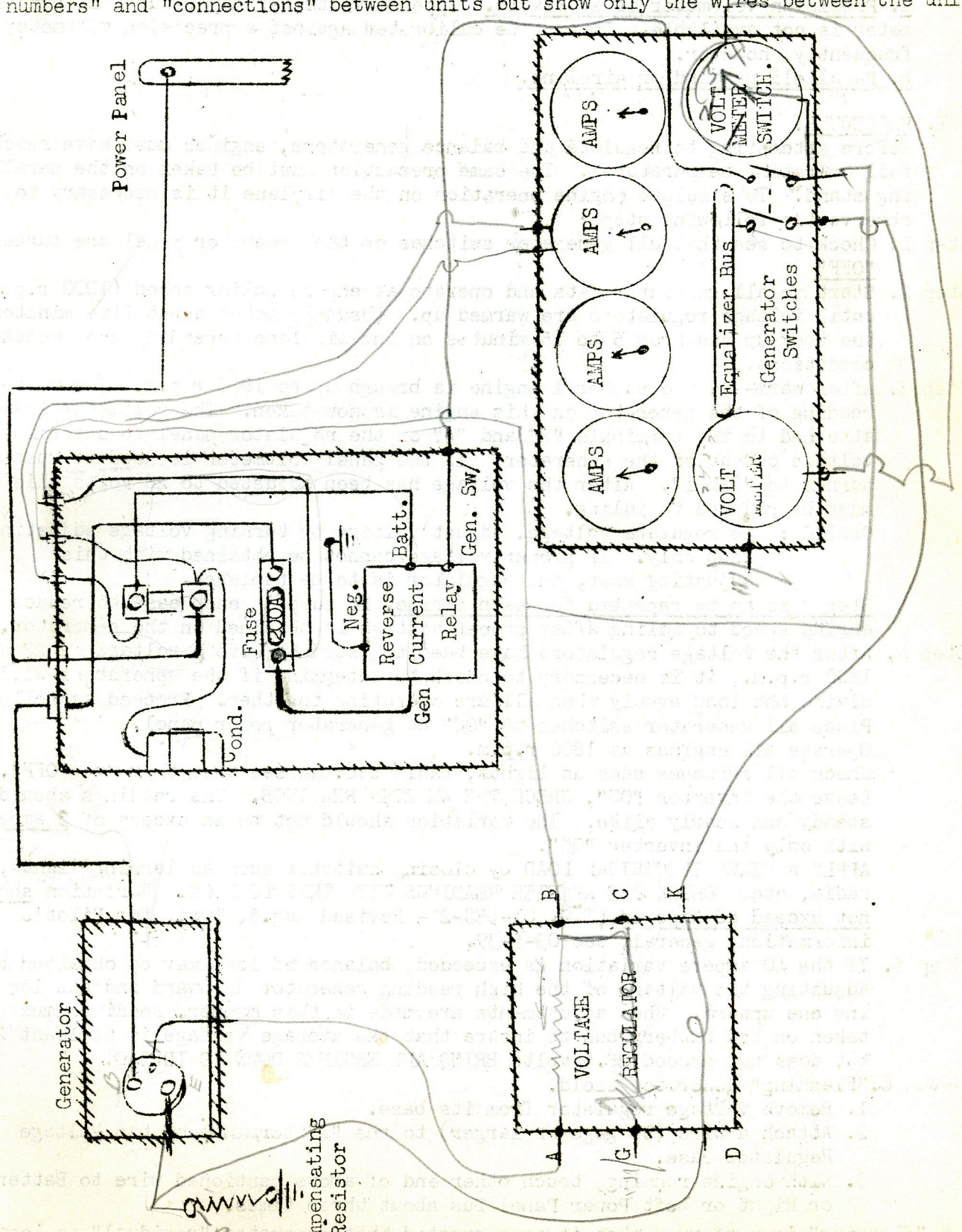
ECLIPSE REGULATOR:

A to B	0.2	0.3 ohm.	O to P	5.0	0 to 10.2
K to D	0.5	0.4	O to B	5.2	0 to 10.2
M to N	21.5	31.0	R to S	23.	37 to 41



GENERATOR POWER CIRCUIT

Procedure: Complete the wiring of the "generator power circuit" units from the ship using the "Circuit Wiring Diagram" Book when necessary. Do not list the "wire numbers" and "connections" between units but show only the wires between the units.



I. 25-HOUR INSPECTION OF GENERATOR SYSTEM Ground Check of Voltage Regulators. Paralleling generators, checking reverse current relays.

II. TOOLS AND EQUIPMENT
a. Precision voltmeter if available. Type B1 voltmeter may be used if precision meter is not available. It must be calibrated against a precision voltmeter frequently, however.
b. Paralleling stand or airplane.

III. PROCEDURE:
Before attempting to regulate and balance generators, engines must have reached full operating temperatures. The same precaution must be taken on the paralleling stand. To simulate engine operation on the airplane it is necessary to observe the following steps:

Step 1. Check to see that all generator switches on the generator panel are turned to "OFF"

Step 2. Start up all generator sets and operate at engine idling speed (1000 r.p.m.) until voltage regulators are warmed up. (Usually takes about five minutes on the mock-up and from 5 to 15 minutes on the airplane depending upon weather conditions.)

Step 3. After warm-up, the number 1 engine is brough up to 1800 r.p.m. The voltage reading of the generator on this engine is now taken. The voltmeter leads are attached to the terminals "B" and "G" on the regulator panel to determine the voltage output of the generator. If the panel voltmeter is used it must be turned to "GEN 1". After the voltage has been adjusted to 28 volts this engine must be reduced to idling.
CAUTION: To regulate voltage, adjust voltage by turning voltage adjusting knob only. If proper voltage cannot be obtained with this adjusting knob, the regulator is to be replaced.
Step 3 is to be repeated for each engine. Be sure in each case to reduce engine speed to idling after proper voltage is obtained on the generator.

Step 4. After the voltage regulators have been adjusted to give a voltage of 28 at 1800 r.p.m., it is necessary to check to determine if the generators will divide the load evenly when all are operating together. Proceed as follows:
Place all generator switches to "ON" on generator power panel.
Operate all engines at 1800 r.p.m.
Check all switches such as lights, radio etc. to see that they are "OFF".
Leave the inverter "ON", CHECK THE AMMETER READINGS. The readings should be steady and nearly alike. The variation should not be in excess of 3 amperes, with only the inverter "ON".
APPLY A HEAVY ELECTRICAL LOAD by closing switches such as landing lights, radio, etc. CHECK THE AMMETER READINGS WITH THIS LOAD ON. Variation should not exceed 40 amperes.(T.O. 01-5EC-2 - Revised Aug.5, 1944, for Pilot's information, general, see 03-5-39.

Step 5. If the 40 ampere variation is exceeded, balance of load may be obtained by adjusting the voltage of the high reading generator downward and the low reading one upward. When adjustments are made in this manner, readings must be taken on the battery bus to insure that the average voltage is at least 28 but does not exceed 28.5 volts BRING ALL ENGINES DOWN TO IDLING.

*Step 6. "Flashing" generator field.
1. Remove voltage regulator from its base.
2. Attach a wire (18 gage or larger) to the "A" terminal of the Voltage Regulator Base.
3. With engine running, touch other end of above mentioned wire to Battery Bus or Right or Left Power Panel Bus about three times.

* "Flashing" is performed when it is suspected that generator "residual" is lost, or when a "reverse field" is encountered in generator.

25-HOUR GENERATOR INSPECTION (Continued)

REVERSE CURRENT RELAY

PURPOSE

A relay for each generator is located in the junction box near the engine nacelle. Access to the relay is obtained thru the wheel well.

The relay performs the following functions:

1. Closes the power circuit from the generator to the battery when the voltage of the generator is sufficient to charge the battery.
2. Opens the power circuit of the generator to the battery when the generator becomes inoperative.

INSPECTION

Step.1. Check the closing voltage. (After the generators have been paralleled and with engines idling.)
Place the generator switch of #1 "ON".
Accellerate the engine slowly and observe the panel voltmeter on "GEN.1". There will be a gradual rise in voltage until the relay "cuts in" at which time a noticeable dip will show on the voltmeter needle. This dip should occur when the voltmeter reads 26.5 volts. Tolerance ±.5 volts.

Step 2. Check the opening current value.
With the relay "cut in" as in the above step, reduce the engine speed gradually. Watch the ammeter "No 1" on the panel. As the engine speed reduces the ammeter reading will reduce until it has a negative value. The relay should cut out before this negative value reaches 20 amperes. Usual opening values are -8 to -25 amperes.

REPEAT THE ABOVE STEPS FOR EACH REMAINING ENGINE.

Step 3. ADJUSTMENTS

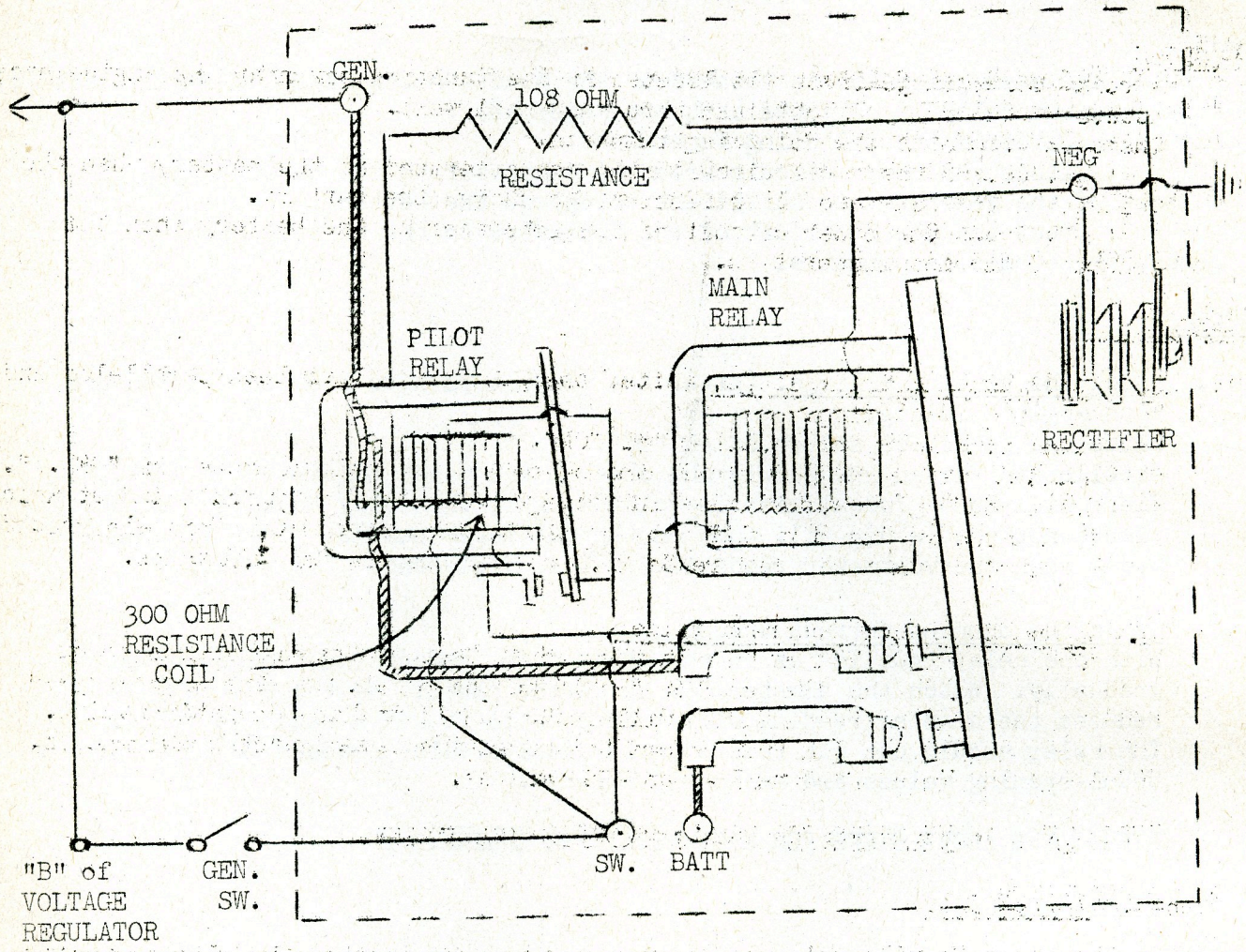
On the Leece Neevile relay adjustment may be made on the closing voltage by turning the small slotted knurled nut near the terminal marked "GEN"

On the General Electric relay the voltage adjustment is made by turning a small screw in the spring clip immediately above the name plate. On most of the G.E. this position is marked "Adjust voltage here".

On the Westinghouse relay the voltage adjustment is made by turning a small screw in the small coil. The screw adjusts the position of the armature in the coil.

IF THE ABOVE ADJUSTMENTS DO NOT CORRECT RELAY FAULTS, THE RELAY MUST BE REMOVED AND REPLACED. (Consult your instructor before replacement)

IV. INSPECTION
Pre-Flight of Generator System:



Preflighting the generator system consists of checking the operation of the generator and the closing of the relays (see relay circuit above). It is performed when engines are warmed up and operating at 2000 to 2550 r.p.m.

V. Perform preflight on generator system as follows:
(ENGINES WARMED UP AND IDLING) Generator power switches "OFF" Inverter "ON". Rev No. 1 engine up to 2000. Turn the generator power switch #1 to "ON". The ammeter for that engine should show a reading of from 10 to 50 amperes. Check the voltage with the airplane voltmeter. Bring the engine down to idle after the check.

Repeat the above procedure for each engine. Record the results:

	AMPS.	VOLTS.
Engine No. 1	_____	_____
Engine No. 2	_____	_____
Engine No. 3	_____	_____
Engine No. 4	_____	_____

Job Sheet
III-13

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

PHASE III
ENGINE ELEC.

OIL DILUTION SOLENOIDS.

PURPOSE:
Oil dilution, to facilitate starting, is accomplished by admitting gasoline into the oil at the engine Y-drain. When the valve is operated by the oil dilution solenoid, fuel runs into the oil line.

PROCEDURE:
In the circuit below, list the harness numbers as taken from the ship and give exact name and location of cannon plug disconnects.

INSPECTIONS:
Daily Inspection: Check for operation. (A "click" signifies satisfactory operation.)
RESULTS: If not operating, trouble shoot the circuit.
Preflight and 50-hr Inspection: Check for operation. (A drop in fuel pressure indicates satisfactory operation.)

PRIMER SOLENOIDS

PURPOSE:
Each engine is equipped with a primer solenoid which, when opened, permits fuel to flow thru to the intake manifold on the upper eight cylinders, providing the fuel booster is on.

PROCEDURE:
In the circuit below, list the harness numbers as taken from the Circuit Wiring Diagram Book or the ship and give exact name and location of cannon plug disconnec

INSPECTION:
Daily Inspection and Pre-Flight and 50-Hr Inspection: is the same as for Oil Dilution given above.

PHASE III
ENGINE ELECT. 200

Airplane & Engine Mech Course (Special B-24)
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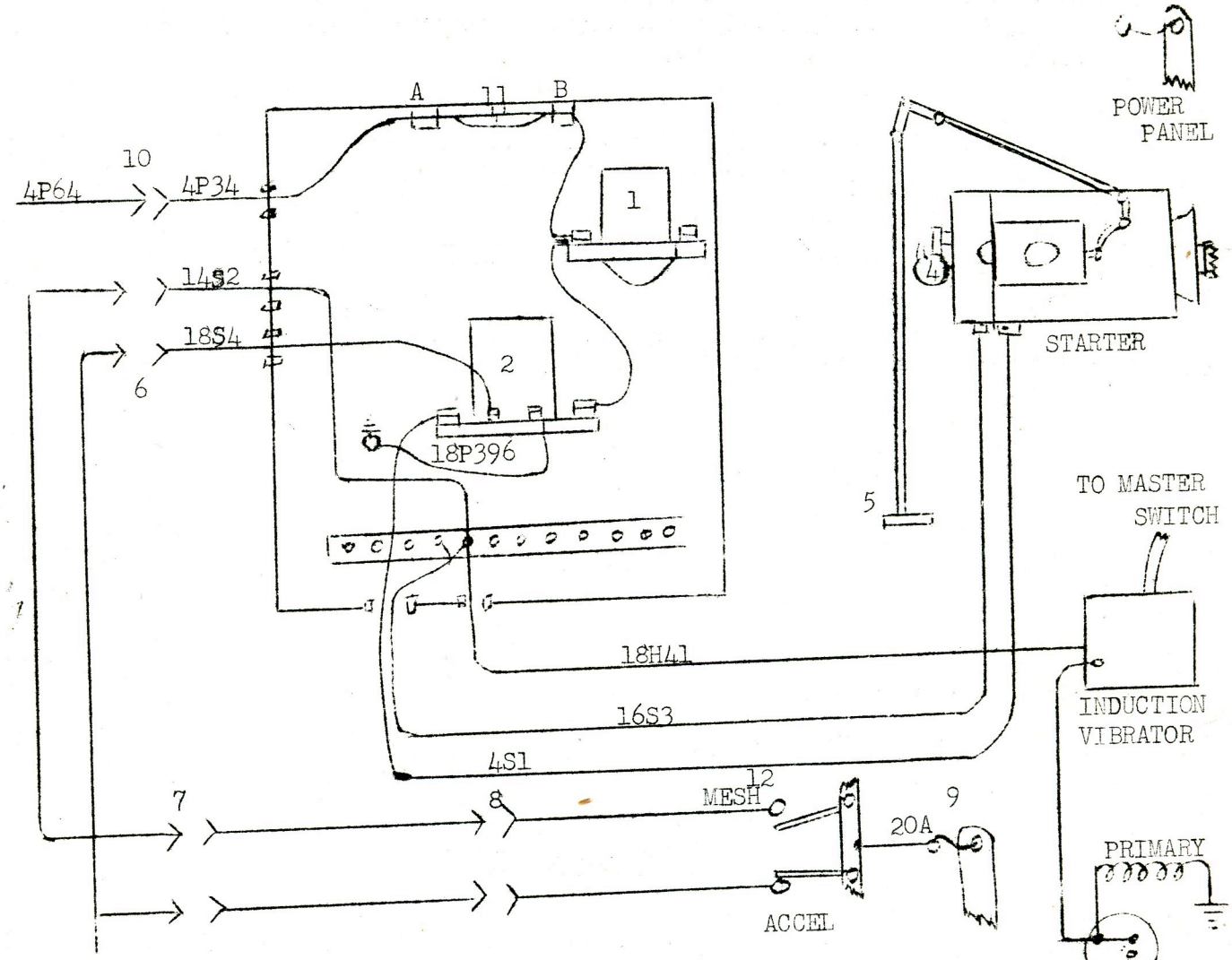
Job Sheet
III-14



PROCEDURE:

Locate and name equipment listed by numbers.

1. Restriction Solenoid
2. Energizing "
3. ~~Starter~~
4. Trip release
5. Hand Engage
6. Common flexible
7. Wire Disconnect
8. Plug disconnect
9. Cockpit fuse box
10. Engine fire wall
11. Current limiters
12. Accessory section

Fill in missing wire numbers for a particular engine from ship.
Complete drawing of power circuit wire 4P64 to power panel.

Use Test light for following (Check A and B with "mesh" and "accel" switch "off".
(Check C with "mesh" switch "ON". _____
("Accel" switch "ON". _____

Job Sheet
III-15

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

PHASE III
ENGINE ELEC. 200

PROPELLER GOVERNOR CIRCUIT

PURPOSE:

The propeller governor maintains constant speed and also by means of double throw r.p.m. control switches changes the pitch of the propeller. Throwing the switch to "Increase" r.p.m., decreases the pitch of the propeller and increase the r.p.m. until the "limit switch" in the propeller governor head cuts off the current to the propeller governor motor and allows current to go to the "propeller limit indicating light" in the cockpit. Throwing the switch to "Decrease" r.p.m., decreases the r.p.m. until the "limit switch" in propeller governor head cuts off current to the motor and sends current to the "Propeller limit indicating light" in cockpit.

PROCEDURE:

Check the circuit for operation and "trouble shoot" the circuit if necessary. Check for the time of operation from "Increase R.P.M." to "Decrease R.P.M.", noting if "indicator light" operates when limits are reached.
Normal time of operation 12 to 14 seconds.

Engine # 1 time _____ Engine #3 time _____
Engine #2 time _____ Engine #4 time _____

Poor connections may cause longer time of operation.

Give location of the following:-

Fuse Location _____.

Switch Location _____.

Propeller Governor Junction Box _____

Limit Lights _____.

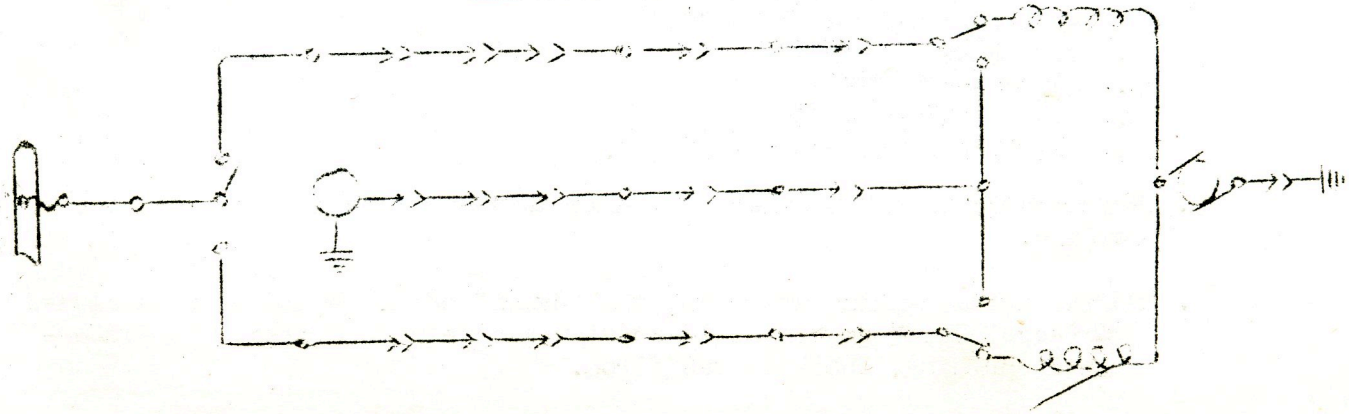
What type of switch is used to operate the propeller governor?

_____.

INSPECTION

Inspect the condition of the electric wiring of the circuit for solidarity of connection and security of mounting of the motor.

PROPELLER GOVERNOR CIRCUIT



G-6 STARTER (Continued)

INSPECTION, 50-HOUR:

1. Remove window strap.		
2. Check brush length	2. The maximum permissible wear of the brush is 3/16" from a new length of ½". If a new brush is installed it must be at least 50% seated with 0000 sandpaper. (See instructor before removing.)	2. Condition _____
3. In checking brush spring tension raise spring 1/8" clear of brush box.	3. Be sure brush spring release handle is in the "ON" position. Tension should be 24-26 oz.	3. Tension _____
4. Inspect commutator and clean with 0000 sandpaper if necessary and remove dust with air blast.	4. If commutator is rough. pitted, or badly burned report the condition to your instructor.	4. Condition _____
5. Clean binding brushes and holder with cloth moistened in undoped gasoline if necessary.	5. Brushes should be a free fit in the brush boxes without excessive side play.	5. Condition _____
6. Replace window strap, and be sure to replace all screws.		_____

HAND STARTING: Move the brush lifting lever to "OFF". Crank to about 16,000 r.p.m. (100 r.p.m. on hand crank). Test for free run time. (Should be about four minutes.) Always move brush lever to "ON" position and RESAFETY after hand cranking.

ELECTRIC STARTING:

A. Make the following electric checks before starting an engine:
   1. Generator switch - "OFF"
   2. Intercooler Shutters - "OPEN"
   3. A.C. Power (Inverter - "ON"
   4. Cowl Flaps - "OPEN"
   5. Gyros - "CAGED"
   6. Booster Pumps - "ON"
   7. Ignition Switches - "BOTH ON".

B. Prime engine 4 to give seconds while starter is being energized for 12 seconds.

C. During actual engine starting, the "Crank" switch would next be closed and "accelerate" switch would continue to be held closed, with intermittent priming, until engine fires.

Job Sheet
III-16

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

PHASE III
ENGINE ELEC. 200

INDUCTION VIBRATOR

Reference: T.O. 03-5-44 and amendments thereto.

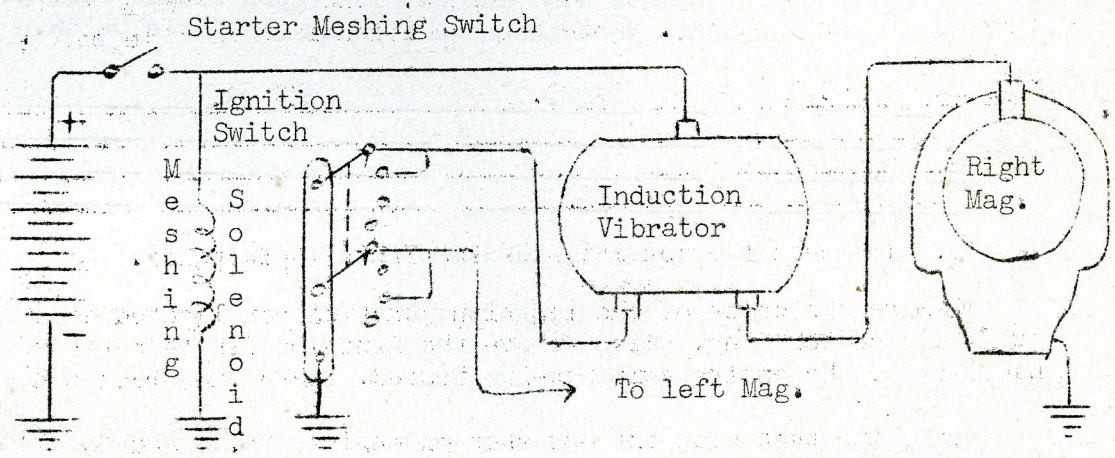
I. Title: Familiarization Sheet

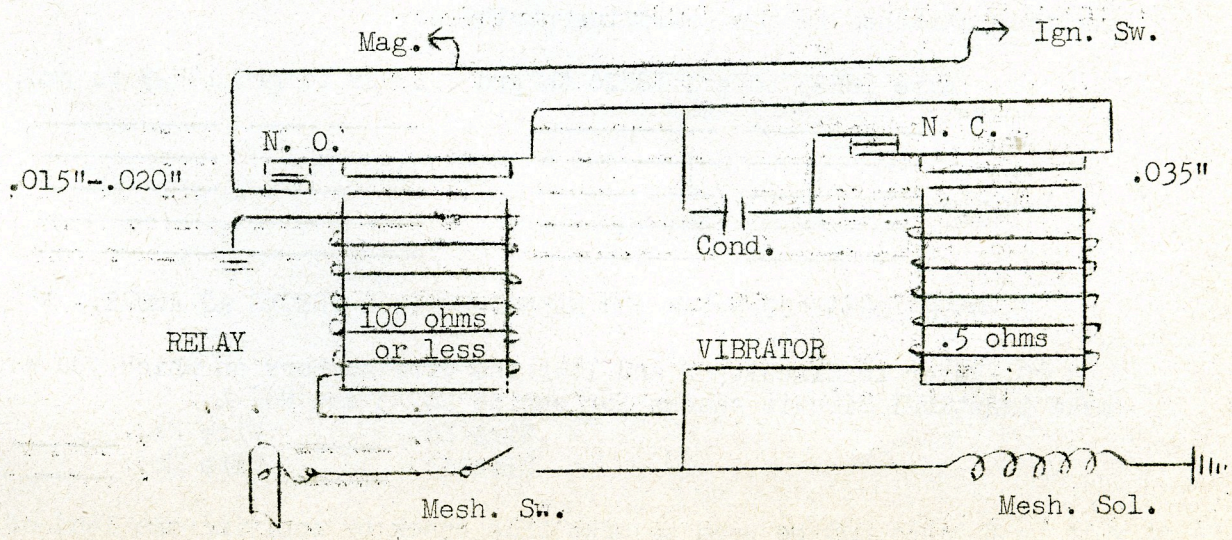
II. Objective: To instruct students in the function, service, inspection and maintenance of the VJR-24B3 Induction Vibrator, as required in first and second echelon.

III. Function: Its function is to supply, by the use of vibrator points, and interrupted battery current through the primary winding of the magneto coil, which then acts like a battery ignition coil, producting a shower of sparks, which are distributed through the magneto distributor and cables to the spark plugs. This action takes place during the entire period that the Magneto contact points are open.

Operation: When the ignition switch is in "ON" position and the starter is engaged, the current from the battery is sent through the relay coil, causing the relay points to close. Closing of these relay points completes the circuit of the vibrator coil and the vibrator produces a rapidly interrupted current which goes to the primary winding of the magneto.

WIRING DIAGRAMS





I. MAGNETO AND INDUCTION VIBRATOR GROUNDING SWITCH CIRCUITS.

II. PURPOSE AND TYPE

Grounding switches are provided on the magneto circuits for the purpose of stopping the engines by grounding out the circuits. The grounding switches also insure that the magneto and induction vibrator circuit are made inoperative during routine tests that require hand turning of the propeller.

The engine is also provided with an ignition disconnect plug that automatically grounds the magneto when the plug is pulled out; thus insuring safety to the mechanic while making adjustment on the engine.

Checking magneto circuits: At engine run-up the magneto ground circuits are checked by momentarily turning the switches to "L" "R" and "OFF". In case of failure of the circuits they may be checked for fault with an ohmmeter.*

III. PROCEDURE:

A. To check the condition of the ignition disconnect plug. (See Circuit H 1.)

Remove the disconnect plug and check the female or socket side of the plug to ground at points A,B, and G. The check should indicate that the points are grounded. Note the condition in the table below.

Points.	ENG. 1	ENG. 2	ENG 3.	ENG. 4
A				
B				
G				

B. To check the condition of the Ignition Switches.

Remove the cover of the ignition junction box located at station 4.2 above the center wing. Also remove the ignition disconnect plug in the nacelles of the entire switch being tested. Turn the crash bar up.

Make the test with the ohmmeter on engines No. 1 and No. 2 with the ignition switches in the following positions:

	Wire 18H25 to grd	18H26 to grd	18H28 to grd	18H29 to grd.
"OFF"				
"L"				
"R"				
"BOTH"				

TURN THE CRASH DOWN BAR AND MAKE IDENTICAL CHECKS AS ABOVE. *

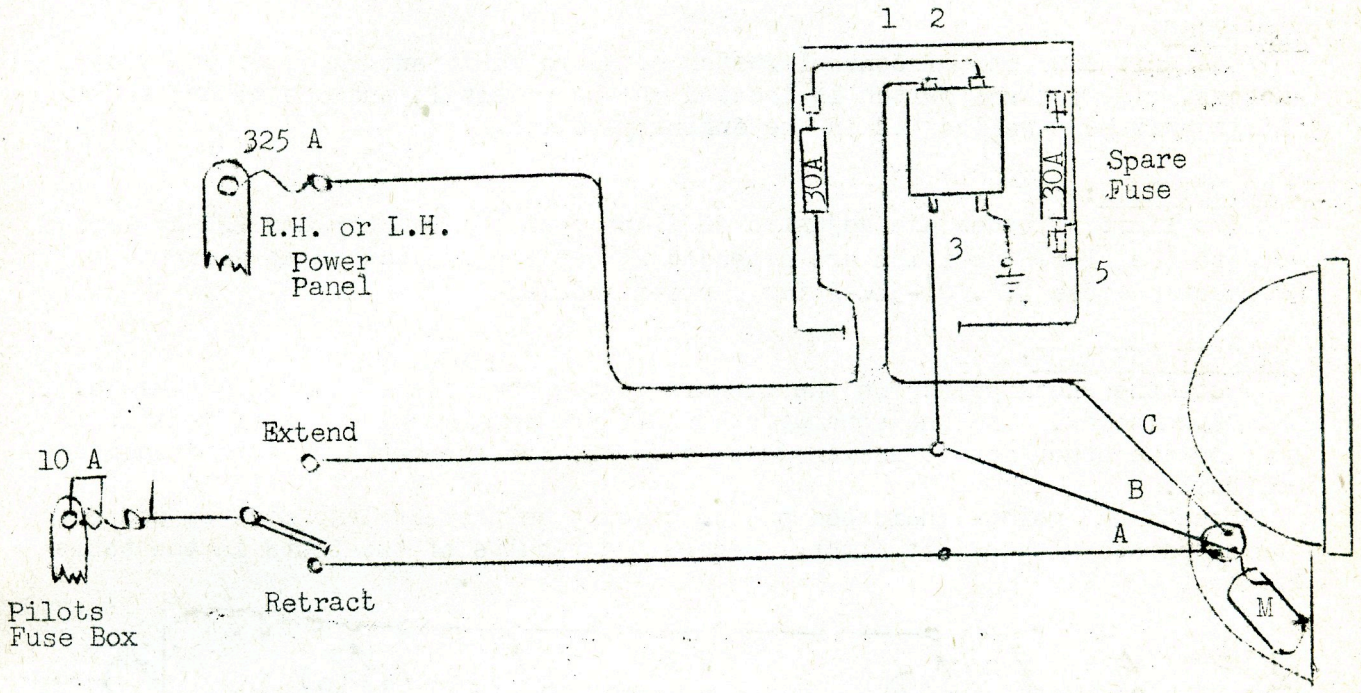
C. Refer to Circuit H2 and list the wire numbers on which you would make identical circuit checks for engine No. 3 and No. 4.

Wire No. _____ Wire No. _____
Wire No. _____ Wire No. _____

*A 24 volt test light may be used to make this check by applying one lead of the test light to a "hot" bus.

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

LANDING LIGHTS CIRCUIT



PROCEDURE: Check the Landing Lights for operation. If not operating check at points listed below.

Landing Light Operates but filament does not light.

1. Check 325 Amp. fuse in power panel with test light
2. Check 30 Amp fuse in Relay Box in Wheel Well.
3. Check for "click" of Relay in Relay Box by throwing switch to "EXTEND" position and check for power on both sides of Relay (Points listed 1, 2, 3,) with test light.
4. Check ground connections of Relay Switch (Point listed 5)
5. Check cannon plug pin of light labeled "C" with test light with Landing Light Switch in "EXTEND" position.
6. Check (Visually) to see if Landing Light filament is not burned out.

Landing Light Does not "Retract" or "Extend".

1. Check 10 Amp. fuse in Pilots Fuse Box with test light.
2. With switch in "Extend" position check cannon plug terminal "B" of Landing Light with test light. If test light does not light--use schematic print E-1 in circuit wiring book to check back for loss of power.
3. With Switch in "Retract" position check cannon plug terminal "A" of Landing Light with test light. If test light does not light use schematic wiring book point E-1 to check circuit for loss of power.
   NOTE: With Landing Light switch in "Extend" position - landing light does not light until light has extended 10 degrees.
4. If power is obtained at terminals "A" and "B" and motor does not operate, remove and replace complete light assembly (See instructor about this)

COWL FLAP MOTOR CIRCUITS

I. PURPOSE AND TYPE:

The cowl flaps are used to regulate the airflow around the cylinders of the engine and thus provides regulation of engine temperature. Then the engines are operated on the ground the cowl flaps are left in the open position.

II. LOCATION:

The unit consists of control switches, micro limit switches, wiring and motors. The control switch is located on the pedestal, and the motors and micro limit switches are located in the engine nacelles.

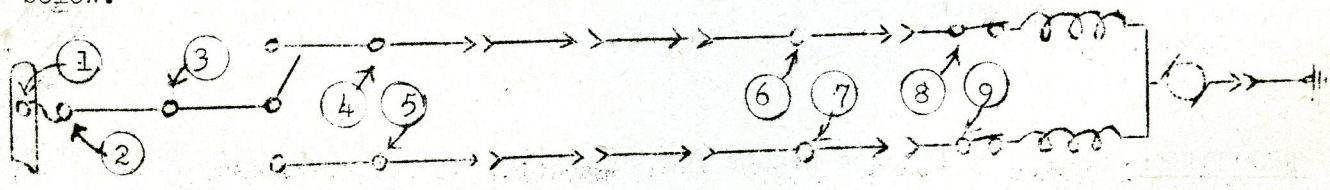
III. ADJUSTMENTS:

The limit switches are adjusted so flaps open $12\frac{1}{4}^{\circ}$ at top and 22° at bottom and to the closed position are extended $2\frac{1}{2}^{\circ}$ at top and bottom at Present Production (See T.O. 01-5EC-2 for earlier models)

IV. CIRCUIT CHECKING:

Note the check points on the circuit of the cowl flap motor of engine No. 1 as given below. Use the schematic circuit provided or draw the schematic of one of the other motors assigned to you. Use the schematic book to obtain the circuit.

Locate the points indicated on the circuit on the airplane mock-up and check these points with a test light. Record the results of the tests in the table below.



Engine No. _____

Check Point	Results	Maintenance required.
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		

V. INSPECTIONS

Preflight: Check for operation and leave flaps fully open at engine run-up.

50-Hour: Check for solidarity of electrical connections, condition of mount and condition of brushes and commutators.

Job Sheet
III-20

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

PHASE III
ENGINE ELEC. 200

INTERCOOLER SHUTTER MOTOR

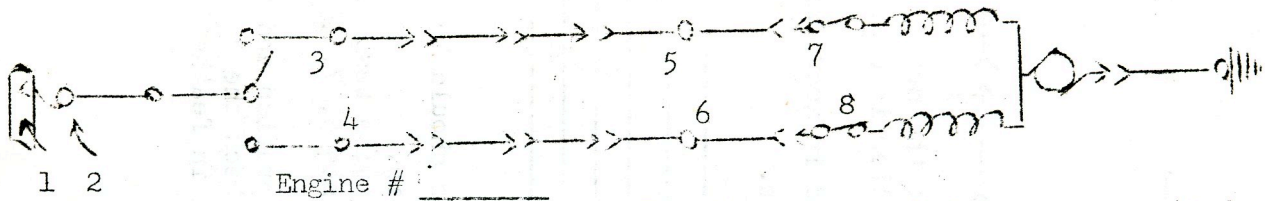
I. TITLE: Checking the circuits of the intercooler shutter motors.

II. PURPOSE AND TYPE:

The intercooler shutters are actuated by an electric motor located on the engine sub-mount. The control switch is located on the Pilot's pedestal. Under normal conditions the intercooler shutters are left open. During engine run-up the shutters must be checked to "OPEN". The pilot closes the intercooler shutters more or less when icing conditions in the carburetor are evident.

III. PROCEDURE:

Note the check points on the circuit of Engine No. 1 as given below. Use the schematic below, or draw the schematic of one of the other intercooler motors. Locate the points on the circuit and check them with a test light. Record the results in the table below.



Engine # _____

Test Point	Results	Maintenance required
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		

IV. INSPECTIONS:

Pre-flight

The shutters are checked to the "OPEN" position before engine run-up

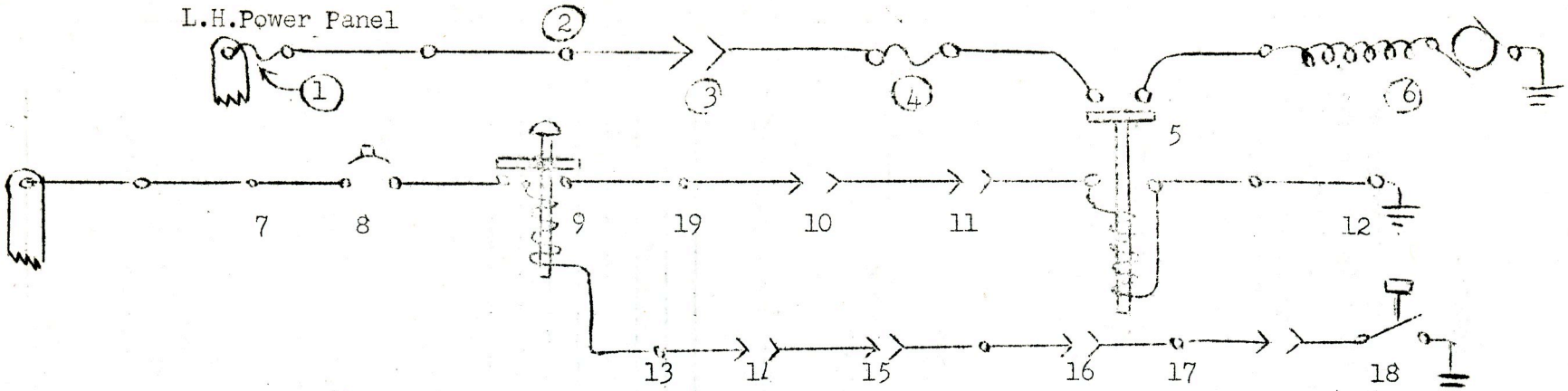
50-Hour:

The wiring is checked for solidarity of connections and the shutter is checked for proper opening and closing. Check the assembly for security of counting, cracks and overheating.

CAUTION: Check to see that all fuse boxes are properly fused. A burned out fuse is an indication of a temporary overload or a serious defect. Check such circuits carefully. Refer to work sheet, "Trouble Shooting Technique," on page 4 (of the work sheets) for a standard method of trouble shooting.

Does the Intercooler Shutter switch have an "OFF" position? _____

FAST FEATHERING CIRCUIT



The Fast Feathering Pump rapidly turns the blades of the propeller to a "streamlined with flight" position, which prevents "windmilling" of the propeller in case of engine failure

PROCEDURE: Identify and locate all points enumerated in above circuit

Use your schematic wiring book to do this.

1 _____	7 _____	13 _____
2 _____	8 _____	14 _____
3 _____	9 _____	15 _____
4 _____	10 _____	16 _____
5 _____	11 _____	17 _____
6 _____	12 _____	18 _____

Check Operation of the Fast Feathering Pumps.

In case pump fails to function, the following points should be checked:-

1. Reset overload circuit breaker and try again.
2. Check fuses in power circuit to pump motor with test light.
3. Check for "power" with a test light at points 5, 7, 19, 12, 13, 17, 18 with Fast Feathering Switch closed.
4. Check solenoid relay switch for correct operation and test for current.
5. If feathering switch does not "hold in", check the "pressure cut out" switch in propeller unit.
6. Check condition of commutator, and brushes in feathering motor.

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LOCATION OF BOMB CONTROL UNITS

OBJECT: To learn the location of units associated with the bomb controls.

DIRECTIONS; Locate the following items as to station number and compartment. Refer to wiring diagram book B1, B2, B3 and F2.

UNITS	STATION NO.	LOCATION
1. Agastat adjustment	0.1	Bomb Control Pannel
2. Sel. Train Switch	0.1	" "
3. Nose Arming indicating light	0.1	" "
4. Fuse for Bomb door Indication lights	0.1	" "
5. Fuse for three volt transformer	2.0 – 2.1	Flight Deck
6. Firing key (Bomb Release Switch)	0.1	LHS
7. Bomb door safety switch	6.0	Rear Bombays
8. Bomb Station Ind. light fuse	4.0	Bombay Bay
9. Lever interlock switch	0.1	Bomb Comp
10. A.C. Relay Switch fuse	2.0 – 2.1	Flight Deck
11. 2000 lb. Station Ind. light	0.1	Control Pannel Bomb Comp
12. Counter knob	0.1	Bomb Control Pannel
13. Bomb Release Ind. light	0.1	Bomb Control Pannel
14. Bomb Release units	4.2 + 5.3	Bomb Racks Bomb Bays
15. Nose Arming solenoids	" "	Forward Side Bomb Racks
16. Bomb formation approach light	10.	Tail (White)
17. Bomb release formation light	10.	Tail (Red)

ARMAMENTS AND HEATERS #

Job Sheet III-23

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BOMB BAY DOOR CIRCUIT

OBJECT: To learn how the bomb bay door switches energize the rack selector and the bomb door indication lights.

FORWARD: If either switch fails to operate, the racks on that side of the ship will be inoperative

EQUIPMENT: A test light, a 3/8 socket wrench and "T" handle, a schematic wiring diagram book and a 15 "A" fuse.

PRECAUTIONS: Do not disturb switches or cannon plugs, turn off all switches when finished.

DIRECTION: Refer to Wiring Diagram, B-3 and to "Y" section on terminal strips and plugs. With power on ship and bomb bay door switches closed, check circuit for trouble at the following points and record the results. Advise instructor when the circuit has been repaired.

Reference	Results
1. F4 Fuse box Sta. 4.0	
2. Y6 Sta. 4.0	
3. Q2 Sta. 5.1	
4. Y9 Sta. 5.3	
5. L.H. Door Switch Sta. 5.4	
6. Y-10 Sta. 4.0	
7. Y23 Bombardier's Panel	
8. L.H. Door Ind. light	
9. Y9 Sta. 5.4	
10. R.H. Door Sw. Sta. 5.4	
11. Y9 Sta. 5.3	
12. Y9 Sta. 5.4	
13. Y10 Sta. 4.0	
14. Y23 Bombardier Panel	
15. R.H. Door Ind. Light	

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QUESTIONS

1. What is the amperage rating of the fuse in this circuit?

2. If the right door indicating lights do not operate, what would you check first?

3. Which switches need to close to supply current to the rack selectors?

4. Where are the rack selectors located?

5. If the right and left rear bomb racks fail to operate but the front racks function, how can you tell whether or not the trouble is in the rack selectors?

6. Refer to drawing B3. A test light is connected between Y9 and Y10 with the bomb doors open and the test light lights. Locate trouble.

ANSWERS

1. _____.

2. _____.

3. _____.

4. _____.

5. _____.

6. _____.

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BOMB WARNING LIGHT CIRCUIT

Bomb Formation approach light (White) Bomb Formation Release Light (Red)

OBJECT: To learn how the firing key controls the agastat through the intervalometer and how the agastat controls the Bomb Formation lights.

FORWARD; When the intervalometer is set on "train" and the counter knob set on a number of bombs, closing the firing key will cause the intervalometer relay to close and draw power from a new source. The intervalometer then sends impulses to the agastat which in turn powers the red or white light in the circuit.

EQUIPMENT: A test light, a 3/8 socket wrench and "T" handle. The Schematic Wiring Diagram Book and 20A fuse.

PRECAUTIONS: Do not toy with intervalometer or change speed during operation. Allow 60 seconds for it to warm up before using on "train". Turn off when not in use by setting counter knob to zero and sel-train switch to "train". Note operation of agastat relay but do not try to assist it with a screw driver.

DIRECTIONS: Refer to Wiring Diagrams - B-1 for circuit and to Y section for Q strips and plugs. With power on ship set bomber's release lever to "select" and check circuit for trouble at the following points.

REFERENCE	RESULTS
1. Fuse - Bombardier's Panel	
2. Y23 Bombardier's Panel	
3. Lever Interlock Switch	
4. Y23 Bombardier's Panel	
5. Bomb Formation light Switch	
6. Agastat - terminals 1 and 2	
7. Y10 Sta. 4.0 Left	
8. Y9 Sta. 5.4 Left	
9. Y11 Sta. 7.7 Left	
10. Y11 Sta. 9.2 Left	
11. Approach light Sta. 10	

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PART II

Now place wire jumper between terminal 2 and 4 on the agastat and use test light to check Release light circuit at the following points.

REFERENCE	RESULT
1. Y10, Sta. 4 left	
2. Y9 Sta. 5.4 left	
3. Y11, Sta. 7.7 left	
4. Y11 Sta 9.2 left	
5. Release light Sta. 10	

QUESTIONS

1. How long does the Bomb Formation Release light stay on? _____

2. What kind of relay is the agastat? _____

3. Does the Bomb Formation Approach light turn on when the bomb bay doors are opened? _____

4. If intervalometer fails, will Bomb formation release light operate? _____

5. How is intervalometer turned off? _____

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BOMB NOSE FUSING

TYPE A-1 BOMB ARMING CONTROL BOX.

OBJECT: To learn the circuit involved when the bombs are dropped all at once in an armed condition by means of the pilot's emergency release or the release lever on the quadrant.

FORWARD; In case the bombs are to be dropped "armed" as a salvo, that is, all at once, the release unit solenoid does not operate the shackle lever. Instead the bombs are released by a mechanical linkage from the quadrant or emergency release and are armed by the type A-1 bomb arming control boxes which are secured to the forward part of the racks at each bomb station. The boxes are controled simultaneously by the nose fusing switch which is on the bombardier's panel and which has arm and safe positions and is in series with a light on the panel. The light is on when the bomb nose fuse is armed. When the switch is "on" the A-1 holds an arming wire and when the bomb is released the tension on the wire pulls out a nose fuse pin and the bomb is dropped armed.

EQUIPMENT; A test light, a 3/8 socket wrench and "T" handle, the Schematic Wiring Diagram book, and a 20A fuse.

DIRECTIONS: Place the 20A fuse in the receptacle in the bombardier's panel and turn on the nose arming switch. Using a test light and the Schematic Wiring Diagram Book B-2, check the mock-ups at the following reference points. Repair all trouble.

REFERENCES	RESULTS
1. Bombardier's Panel - Fuse	
2. Bombardier's Panel "ON - OFF" Switch	
3. Sta. 4.1 Q 1	
4. L. FWD Rack 14B312	
5. R. FWD Rack 20B331	
6. Terminal L.H. Bomb Bay Sta. 4.4 14B380	
7. L. AFT Rack 14B379	

Have someone turn on and off nose fusing switch and listen for clicking at each solenoid to determine whether or not it is functioning. With the switch "on" insert coin or screwdriver between contacts holding bomb nose fusing wire to check for "holding" of contacts. Also check with switch "off" to check for clearance of contacts.

QUESTIONS

1. What is a salvo? _____
2. Is there any other than the Bombardier's switch for nose arming? _____
3. Are the A-1 units wired in series or in parallel? _____
4. If all units on the R.H. Fwd rack operate but those on the L.H. Fwd rack do not, where would you look for the trouble? _____
5. Why isn't it possible to salvo bombs from the quadrant with the bomb bay doors closed? _____

BOMB RELEASE CIRCUIT

PURPOSE: To learn how the firing key or bomb release switch, energizes the intervalometer and how the intervalometer sends its impulses to the cocked bomb release unit by way of the rack selector causing the unit to release an armed bomb.

FORWARD: If the rack selector switches are in the "ON" position only every fourth impulse from the intervalometer will go to the rack being tested. Therefore, turn on only the rack selector switch for the rack which is to be tested. The release will then be tripped in succession from the bottom to the top of the rack.

EQUIPMENT: A test light, a Schematic Wiring Diagram book, and a 3/8 socket wrench.

DIRECTIONS: Note the references to the diagram book, B-1, B-3 and B-4 given below. Use the test light at these points, to determine the operating condition of the circuit. Study both diagrams until you understand the path of the impulse from the firing key through the intervalometer and rack selectors to the release unit. Have someone operate the firing key in order to furnish power to the check points.

REFERENCES	RESULTS
1. Y23 Bombardier's panel 16B4	
2. Y23 Bombardier's panel 16B 5	
3. Y23 Bombardier's panel 16B217	
4. Release switch R.H.Fwd 16B228	
5. Y5 Sta. 4.0 Left 16B195	
6. Y5 Sta. 4.0 Left 16B200	
7. R.H. Fwd Rack 16B56	

QUESTIONS

1. Where is the ground for the Bomb Station Indication light? _____.

2. Give the correct order in which the impulse for the firing key travels through the following (1) Bomb Release; (2) Intervalometer, (3) Rack selector; (4) Rack selector switch. _____.

3. How many ampers does the bomb release solenoid draw? _____.

4. Are the releases wired in series or parallel? _____

5. When all rack switches are "on" which bomb release operates first? _____

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INTERNAL CIRCUIT OF BOMB RELEASE UNIT

Name _____ Ser. No. _____ Group _____ Date _____

I. Objective

To practice tracing ciruits with a continuity meter or an ohmeter.

II. Tools.

Continuity meter or ohmmeter. Supplementary bomb release units.

III. Preliminary Instructions

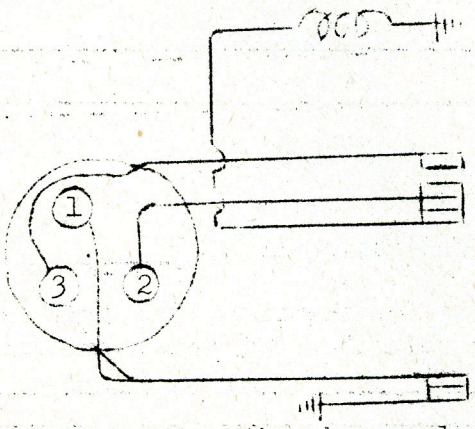
Two or three may work together.

IV. Procedure

1. Cock the release and check continuity as follows:
   a. Pin 1 to ground. _____
   b. Pin 2 to ground. _____
   c. Pin 3 to ground. _____
   d. Pin 1 to 2 _____; 2 to 3 _____; Pin 1 to 3 _____.

2. Trip the release and make the following checks:
   a. Pin 1 to ground. _____
   b. Pin 2 to ground. _____
   c. Pin 3 to ground. _____
   d. Pin 2 to 3 _____

(SKETCH)

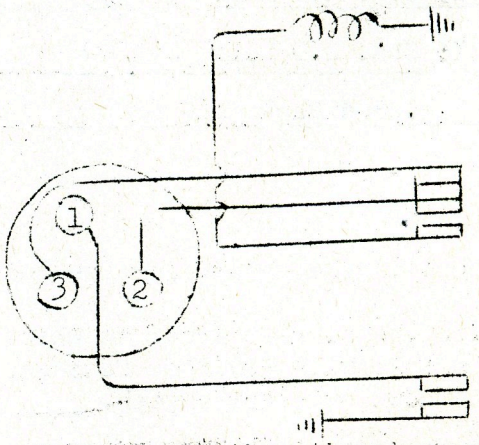


Indicate whether the above release is

Cocked _____

or

Uncocked _____



Indicate whether the above release is

Cocked _____

or

Uncocked _____

Job Sheet
III-28

ARMAMENT AND
HEATERS 300

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

BOMBING MISSION

Name _____ Ser. No. _____ Group _____ Date _____

I. Purpose

To acquaint the student with the routine practice in loading, transporting and dropping bombs.

II. Preliminary Instructions

The routine inspection (inspection of bomb release units and racks, (Job #8) should be performed before attempting this job. As many as five men may be assigned to perform this job, with one man designated as the crew chief.

A. Bomb Loading:

1. Prepare for bomb loading by simulating the opening of the bomb doors. (See that the micro-switches at station 5.4 are closed)

2. Check for the operation of the bomb door indicating lights.

	CONDITION
a. Pilots left door light	_____
b. Pilots right door light	_____
c. Bombers left door light	_____
d. Bombers right door light	_____

3. Place the "Salvo lever" in the "Select" position and check operation of the bomb approach formation light (white) _____
Check the operation of the bomb formation amber indicator light on bomber's panel. _____

4. See that the "Salvo System Cam" is pushed all the way in (or back), and that the "pin" in the telescoping linkage is in place. _____

5. Cock all the bomb releases.

6. Check the operation of the bomb station indicator lights (Inverter must be on for this check. Again turn off these lights. _____

7. Place the "salvo lever" in the "lock" position. (In practice bombs are now loaded). Do not load dummy bombs on the racks in the mock-up, because of safety hazard, except at lowest stations only.

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BOMBING MISSION (Continued)

B. Bomb Dropping by Train:

CONDITION

1. Open the bomb doors. The bomb door indicating lights should be "ON" _____

2. Set the train at 300 miles per hour to drop bombs 400 feet apart. Set it to drop 15 bombs. The amber light on the intervalometer should be "ON". Set "Train-sel" switch to "train". _____

3. Close the rack selector switches as follows: "Left Rear", "Right Rear", "Left Front". Turn on the bomb station indicating lights. The lights should indicate with the inverter on. _____

4. Set nose fusing switch to "ON". Amber light should come on. _____

5. At the bomb run the "salvo lever" is placed in the select position. The bomb approach formation light should light. It may be used in bright, dim, or off position. The amber indicating light should be "ON" when switch is on BRIGHT or DIM. _____

6. On the "target" the bomb release switch is turned to "ON" momentarily. The impulse will release the train of bombs. The first bomb to be dropped should be the No. 1 on the left rear. _____

6a. The amber "bomb release light" in the cockpit should light. _____

6b. The agastat should operate to turn on the red bomb release formation light on the tail. _____

7. For manual dropping of the remaining five bombs, set the intervalometer to "select". Check the timing of the agastat. It should hold the red bomb formation light for five seconds. _____

8. Close the bomb doors and turn off the switches on bomber's panel and on intervalometer. _____

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

AUXILIARY HYDRAULIC PUMP

I. PURPOSE

To furnish hydraulic pressure when engine #3 is not operating and as an aid on a heavy load.

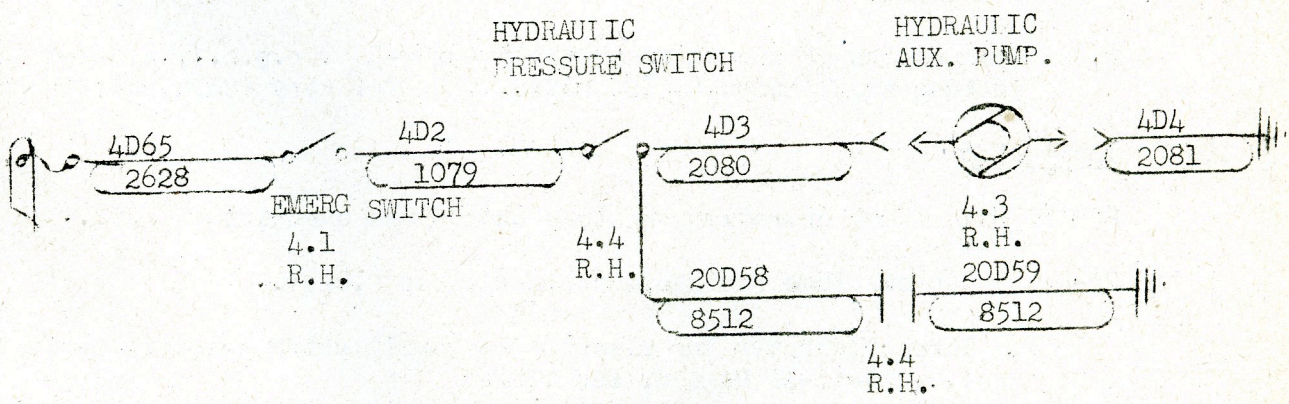
II. PROCEDURE

1. Trace circuit from text and indicate check points.

2. Check for operation.

Number	Results	Maintenance Required
1.		
2.		
3.		

HYDRAULIC PUMP SCHEMATIC



CAUTION: In order to avoid disassembly of switch panels and disconnect plugs, pass them by when point checking a circuit, unless checks show trouble to be at the plug or switch panel.

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

OPERATION AND INSPECTION OF AUXILIARY POWER UNIT AND CIRCUITS

Reference: T.O. 19-45-11

I. Purpose

The Auxiliary Power Unit is used to furnish electric power to the airplane so that battery power need not be used when starting engines. It may also be used as an emergency power in case all electric power fails.

II. Tools and Materials

1. Auxiliary Power Unit.
2. Gas, 91-100 Octane.
3. Oil, Spec. 1065A.

1-1" Wrench		(Box & End)
1-15/16" Wrench		(Box & End)
1-3/4" Wrench		(Box & End)
1	Screwdriver, Medium	
1	Gage - Spark Plug Gap.	

III. Procedure

1. Prepare fuel mixture 1/2 pt. of 1065A oil and 1 gal. of 91-100 gas, (Mix as directed on the engine plate) if fuel is needed.
2. Place the equalizer switch to "OFF" if engine generators on the plane are not operating.
3. Turn "Fuel" valve to "ON".
4. Choke by operating plunger as indicated on the carburetor screen.
5. Turn on A.P.U. Power Switch on bulkhead 4.0 and then energize by depressing starter switch or hand start by using the starting rope provided.
6. When engine is operating properly (3200-3700 r.p.m.), proceed to make voltage adjustments to 28 volts. (Run for very short periods only).

IV. Inspection

PREFLIGHT: Check operation, voltage output and quantity of fuel.

25-Hour: Check plugs for gap and cleanliness .025".

1. Inspect adapter for cleanliness (drill extra holes if necessary). T.O. 19-45-11 Page 8, see VI 2a)
2. 300 Hr. Brushes: Check length so that spring does not ride on carriage.
3. Inspect the ground wire of the brushes. This wire serves as a compensating resistor. Burning out of this wire is reported as a common failure.
4. Make sure that the power switch is "OFF", If the APU is not used. Leaving it "ON may drain the battery.

NOTE: KEEP THE SPARE FUSE BLOCK FULL AT ALL TIMES ! ! ! !

Job Sheet
III-31

ARMAMENT AND
HEATERS 300

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

HEATER CIRCUITS

OBJECT. A. To learn the differences in the wiring of the Bombardier's Pilot's, Copilot's, Radio and Turret heaters.
B. To become familiar with the wiring of the three heater switches.

FORWARD: The bombardier's heaters and the pilot's and copilot's heaters have a return ground wire to the heater fuse box in order to eliminate the magnetic field of the hot wires supplying the fan motors. The switch for one group of heaters is on the bombardier panel and the switch for the other group is on the co-pilot's auxiliary switch panel. The master heater switch is next to the battery switches and is of exactly same type

EQUIPMENT: Test light, screw driver, 3/8 socket wrench, and the Schematic Wiring Diagram Book.

DIRECTIONS: Use test light and after turning on co-pilot's heater switch and master heater switch check the top turret co-pilot's and pilot's heater circuits at the following points. Use Wiring Diagram for references.

REFERENCE	RESULTS
Maste Heater Solenoid 8A103	
Co-p. Aux. Sw. Panel 8A11 and 8A12	
Q2 Sta. 4.0 R.H. 16A15	
Q4 Co-p. Htr. 16A517	
Q4 Co-p. Htr. 16A519	
Q4 Pilot Htr. 18A518	
Q4 Pilot Htr 16A520	

QUESTIONS

1. Will the co-pilot's heater fan operate if the ground wire is removed from the heater? _____.
2. From what source does the heater fuse box receive its power? _____.
3. Why do the pilot's, co-pilot's and bombardier's heaters have a ground wire? _____
4. Why is such heavy wire (#8) used on the bombardier's and co-pilot's heater switches? _____.
5. What type of switch is the master heater switch? _____.
6. How does the heater fuse box differ in its power supply from the other fuse boxes in the ship? _____.

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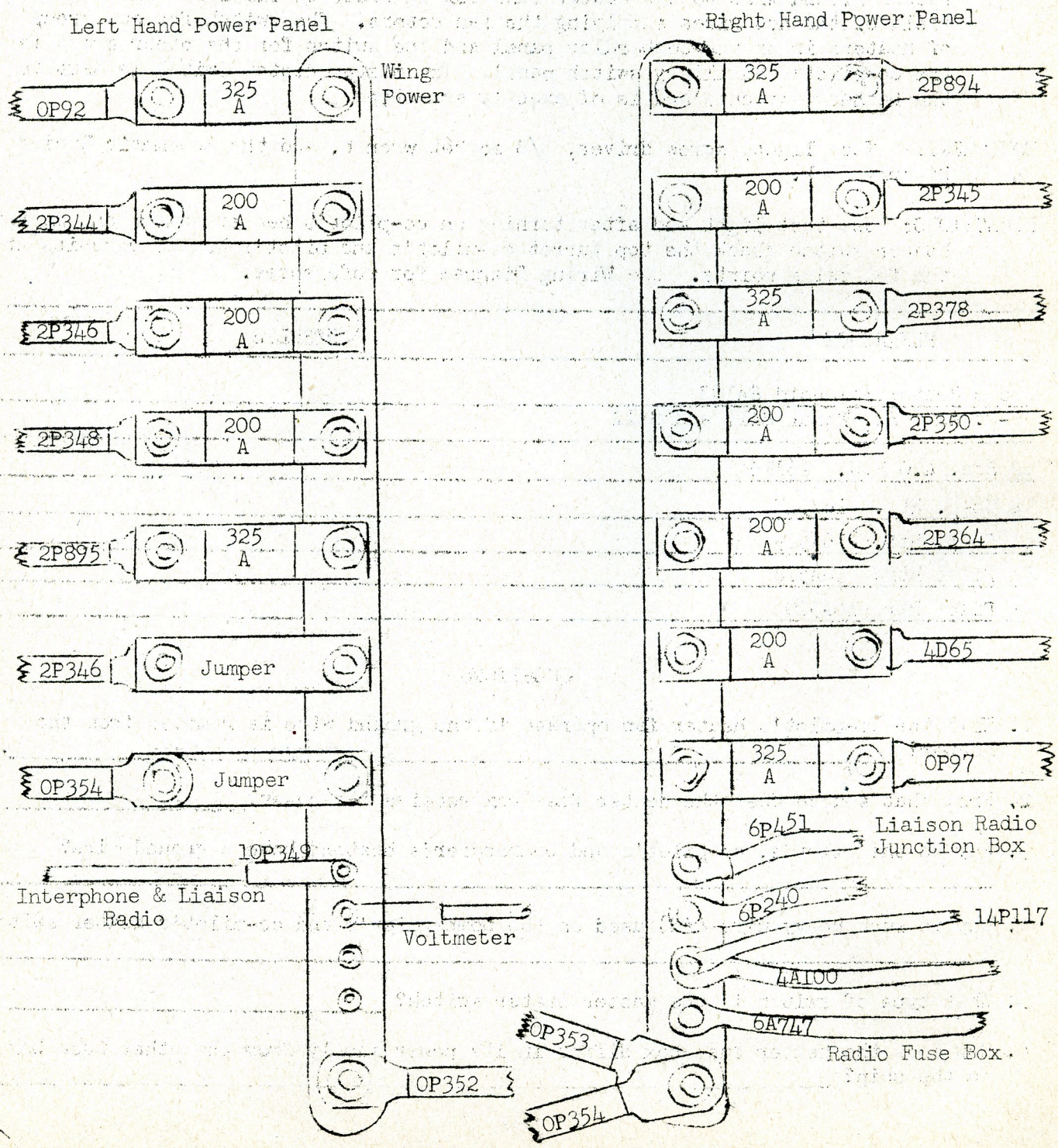
POWER PANEL DISTRIBUTION

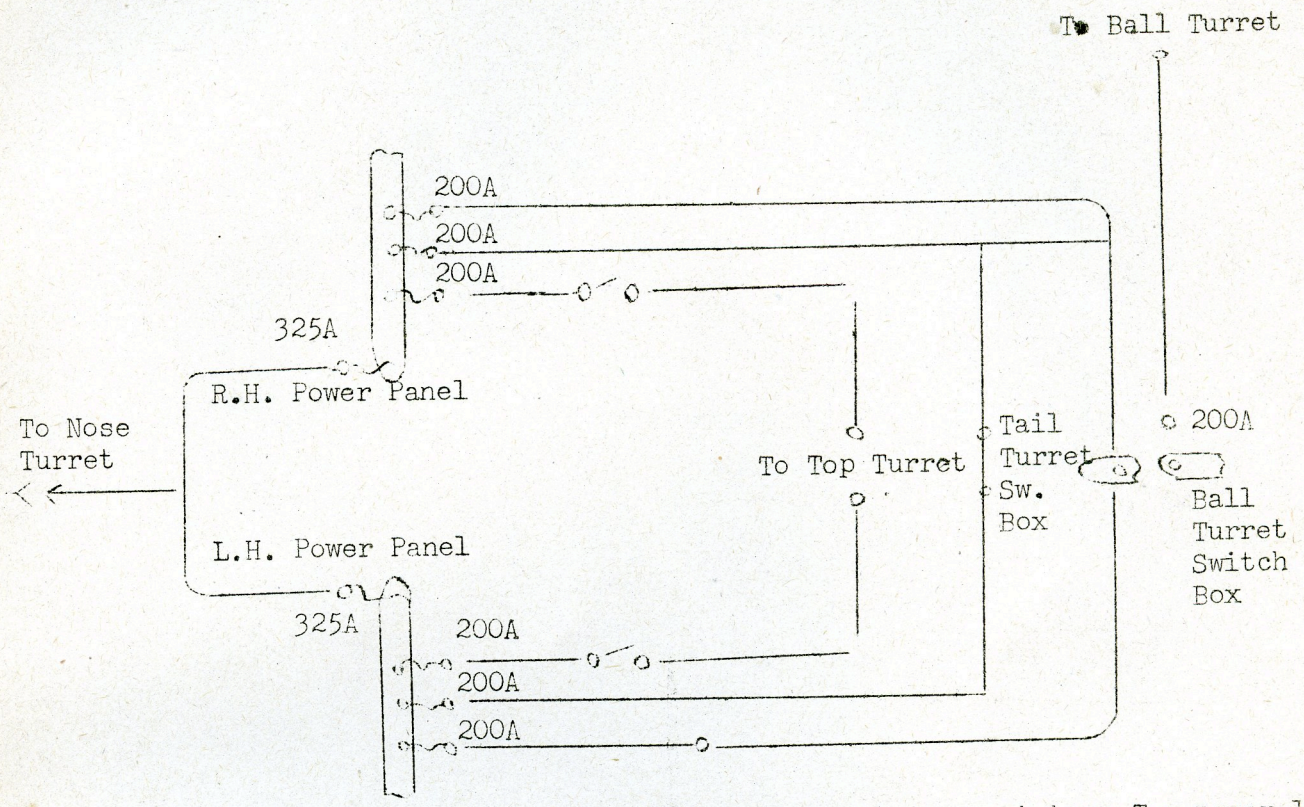
From this drawing and ship, identify the leads and to what accessory they furnish power.



~~Job Sheet~~
III-33

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

ARMAMENT AND
HEATERS 300



Description: The nose turret, top turret, and ball turret each have Two power leads getting power from the Right and Left Hand Power Panels.

Why is this desirable: _____.

Can you tell by visual inspection if the "Current Limiters", commonly called slow blow fuses, have blown? _____.

How would you test Current Limiters (slow blow fuses) for electrical continuity? _____.

Where is the Ball Turret Switch Box located in the ship? _____

_____.

What circuit does the 2 amp. fuse in the Ball Turret Switch Box protect?

_____.

Fill in the wire numbers in the above wiring diagram ------ getting the numbers from the ship.

List fuses blown or missing: _____

_____.

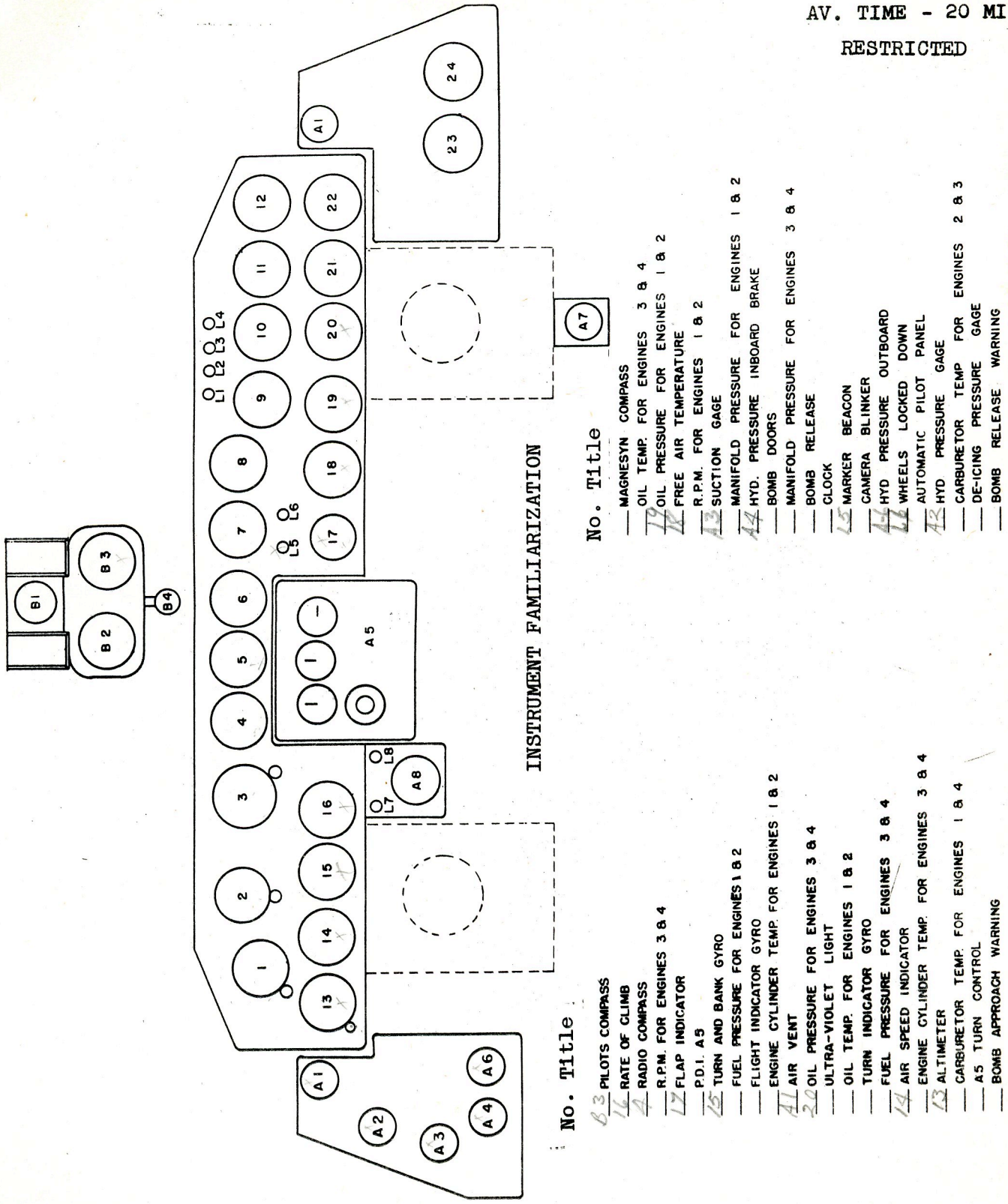
ELECTRICAL - PHASE III
ELECTRICAL CIRCUITS - 400

580th TECHNICAL SCHOOL SQUADRON
Willow Run Airport
Willow Run, Michigan

Job 14
1 - Sheet 1

AV. TIME - 20 MIN

RESTRICTED



Instructions: Place the numbers from the instrument panels in front of the two lists of instruments so each number will correctly indicate the name of the instrument on the panel.

RESTRICTED

COMPENSATING THE COMPASS

(Pilot's B-16, B-17 at 150 hours; Magnesyn at 100 hours.)
References: 05-15-3, 05-15-5, 01-5EC-2, and AAF Form No. 57

I. TOOLS

Non-magnetic screwdriver.

II. INSTRUCTIONS:

1. Put compensating magnets in "neutral" position by lining up two white dots on N-S and E-W compensating screws with dots on case.

2. Head ship N, E, S, and W, and record readings of aircraft compass in "compensating swing" - column two on following page. Estimate readings to within 1/2 degree.

3. Calculate readings for deviation column by subtracting readings of column (2) from column (1). If the column (1) figure is the larger then the deviation is positive, if less, the deviation is negative.

4. Use formulae on bottom of sheet (following page) and fill in figures from deviation column and calculate coefficient C, coefficient B, and coefficient A.

(In subtracting algebraically - as in formula - change the sign of the subtrahend and add). Example:

$$\text{Coeff. } C = \frac{N - S}{2} = \frac{(N) - (S)}{2} = \frac{(-2) - (+3)}{2} = \frac{-2 + -3}{2} = \underline{\underline{-2\tfrac{1}{2}}}$$

5. Head ship N and add coefficient C algebraically to compass reading. Adjust N-S screw so that compass reads this new heading.

6. Head ship E and add coefficient B algebraically to compass reading. Adjust E-W screw so that compass reads this new heading.

7. With ship on any heading add coefficient A algebraically and move compass transmitter (remote reading compass) so that indicator reads this new heading. Do not perform this work on pilots' direct reading compass or on navigator's aperiodic compass.

III. RESIDUAL SWING

1. Swing the ship on 45 degree heading. Fill in the "residual swing" columns 3 and 4. Column 3 is the same as Column 1. Column 4 is the aircraft compass readings.

2. Calculate and record deviations in Column C to M (compass to magnetic) by subtracting (column 3 minus column 4).

3. Calculate M to C (magnetic to compass) readings by subtracting (column 4 minus column 3).

INSTRUMENTS
FF 4000 300

Airplane & Engine Mech Course (Special B-24)
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COMPENSATING THE COMPASS

	Compensating Swing			Residual Swing		Aircraft Comp. No. _____ Date		
	Actual Head (M)	Aircraft Comp.	Dev'n	Actual Head (M)	Aircraft Comp.	C to M		M to C
N 000	0 360	9	-9	0 360	1	-1	000	+1
NE 045				45	48	+3	045	+3
E 090	90	86	+4	90	93	-3	090	+3
SE 135				135	139	-4	135	+4
S 180	180	173	+7	180	181	-1	180	+1
SW 225				225	228	-3	225	+3
W 270	270	282	-12	270	272	-2	270	+2
NW 315				315	317	-2	315	+2
	1	2	1-2	3	4	3-4		4-3

Coeff. C = $\frac{N - S}{2} = \frac{(-9) - (+7)}{2} = \frac{-16}{2} = -8^{\circ}$

Coeff. B = $\frac{E - W}{2} = \frac{(+4) - (-12)}{2} = \frac{+16}{2} = +8$

Coeff. A = $\frac{N + E + S + W}{4} = \frac{(\ \ ) + (\ \ ) + (\ \ ) + (\ \ )}{4}$

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INSTRUMENT TOLERANCES

Altimeter C-12 No tolerance allowable on the ground after scale error correction has been applied. In the air pilots are allowed 30 feet tolerance.

Airspeed D-7	60 to 120 m.p.h.	2	m.p.h. tolerance
	130 to 160 m.p.h.	2.5	m.p.h. tolerance
	170 to 200 m.p.h.	3	m.p.h. tolerance
	200 to 500 m.p.h.	4	m.p.h. tolerance

Turn and Bank A-11 Vacuum 1.8 to 2.05 allowable. If beyond this limit reset to 2 inches.
Pointer tolerance on center index 1/64" with gyro at rest.

Rate of Climb C-2 Reset Hand to "0" position.

Directional Gyro A-5 Replace for calibration if tolerance exceeds the following: Tolerance allowed is ± 3 in any heading.

Flight Indicator - 7 Tolerance of 1/64" allowable if bar always settles to the same position during operation. Tolerance on bar when caged is "0".

Manifold Pressure AN-5770-2 Tolerance 0.25" between 20" and 40" Hg. 0.35" between 40" and 60" Hg.

Tachometers E-13 A	500 - 900 r.p.m.	25 r.p.m. tolerance	20 r.p.m. friction
	1100 - 1500 r.p.m.	25 r.p.m. tolerance	20 r.p.m. friction
	1700 - 2500 r.p.m.	25 r.p.m. tolerance	20 r.p.m. friction
	2700 - 2900 r.p.m.	25 r.p.m. tolerance	20 r.p.m. friction
	3100 - 3500 r.p.m.	30 r.p.m. tolerance	20 r.p.m. friction

Free Air Temp. C-13 Tolerance ± ½° C.

Fuel Pressure C - 14A ± 0.3 lbs./ square in. tolerance.

Oil Pressure B-9 ± 5.0 lbs./ square in. tolerance.
3.5 friction error.

Cyl. Head Temp. B-11 Open circuit by removing lead wire from instrument and set needle to cockpit temperature as indicated by a master thermometer. Tolerance ± 10°

Oil Temp. Ind. A-24 Tolerance ± 4° C.

Carb. Air Temp. F-10 Tolerance ± 3° C

Pilots Compass B-16-17 Tolerance 8° before compensation; 2° after.

Remote Indicating Compass (Magnesyn) Tolerance 4° before compensation; 1° after.

Flux Gate Compass Tolerance - none.

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VISUAL INSPECTION OF PANEL

Reference: T.O. 05-1-1, 05-1-1C, 05-1-10

Note: Use symbols as follows:

1. Red cross (X) indicates "Dangerous Condition".
2. Red diagonal (/) indicates "Maintenance Work Necessary".
3. Red dash (-) indicates "Required Inspection not Made".
4. Black initial indicates "Thoroughly Inspected - Condition Satisfactory".
5. Black line drawn vertically (|) indicates "Not Ap licable".

	Enter Symbol Denoting Condition	Remarks Pertaining to Defects, Etc.
1. Inspect condition of panel mounting		
a. Check lord mounts (rubber shock-absorbers) for position and tightness	a.____	a.____
b. Check bolts (must be long enough to lock)	b.____	b.____
c. Check rigidity of each instrument on panel	c.____	c.____
2. Inspect lighting		
a. Check black light	a.____	a.____
b. Check individual light on compass (bulb & Wire)	b.____	b.____
3. Inspect glass covers		
a. Check for looseness	a.____	a.____
b. Check for cracks	b.____	b.____
c. Check for dirty or scratched condition	c.____	c.____
d. Check for position marking. (White line)	d.____	d.____
e. Check operating markings. (Red and green)	e.____	e.____
1. Fuel Pressure (green 14-16)	1.____	1.____
2. Oil Pressure (Green 75-90)(Red 60&105)	2.____	2.____
3. Manifold Pressure (Green 26.5-34) (Red 48)	3.____	3.____
4. Tachometer (Red 2700)	4.____	4.____
5. Oil Temperature (Green 60-90)	5.____	5.____
6. Cyl. Hd. Tem. (Green 125-232, Red 260)	6.____	6.____
f. Check free air thermometer reading.	f.____	f.____
4. Inspect luminous markings:		
a. Check for discolored markings	a.____	a.____
b. Check for chipped markings	b.____	b.____
5. Inspect for tightness of connections		
a. Check vacuum fittings to suction and gyros	a.____	a.____
b. Check Pitot-static fittings to altimeter, airspeed, and rate of climb	b.____	b.____
c. Check cannon plugs to electrical instruments for solidarity (do not remove).	c.____	c.____
6. Inspect Clock: Wind and set with Station Master Clock	a.____	a.____

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TACHOMETER

Reference: T.O. 05-1-8, 05-1-26, 05-55B-1

I. PURPOSE AND TYPE

The E-13A Tachometer has an A.C. generator mounted on the engine accessory section the voltage and cycles of the generator vary with the engine RPM, and an Indicator on the instrument panel. It shows revoltuions per minute of the crank shaft.

II. PRELIMINARY INSTRUCTIONS.

Attach long flexible tach drive shaft to C-1 tachometer drive and to generator connection. Avoid sharp bends, 6-inch radius is the minimum tolerance. Turn control of C-1 to "Tach Drive". (Warning: Never shift from "Pump Drive" to "Tach Drive" or vice versa with motor running). Set Power Selector to "AC".

III. OPERATIONAL CHECK

Turn on "AC Motor" on C-1 test set and adjust speed with "AC" speed control. Check panel tachometer against C-1 tachometer at the following speeds in given order. (With speeds increasing, the speed must be brought up to but not exceeding the required speed).

Tolerance: See Tolerance reference sheet (Page 79).

Record readings below and circle those readings which are off tolerance.

		Eng. 1	Eng. 2	Eng. 3	Eng. 4
a.	0	0	0	0	0
b.	1500	1500	1500	1500	1500
c.	2000	2000	2000	2000	2000
d.	2500	2500	2500	2500	2500
e.	3000	3000	3000	3000	3000
f.	2500	2500	2500	2500	2500
g.	2000	2000	2000	2000	2000
h.	1500	1500	1500	1500	1500
i.	0	0	0	0	0

IV. FINAL INSTRUCTIONS

Turn off "AC Motor" on C-1.
Lay tachometer shaft in tray attached to wall at locker room.

V. PERFORM 50-HOUR INSPECTION on tachometer and record results in Form 41B.

VI. REMOVAL AND REPLACEMENT.

In case of a defective instrument, consult your instructor regarding removal.

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OIL PRESSURE GAGES

Reference: T.O. 05-1-8, 05-55B-1

I. PURPOSE AND TYPE

The oil pressure gages show the pressure at which oil is forced to bearings and other points in the lubricating system of the engine assembly.

The transmitter is of the autosyn type, with a Bourdon tube to operate the transmitter armature.

II. OPERATIONAL CHECK

Preliminary Instructions:

Use portable pressure unit from the C-1 set to supply pressure to the oil pressure gage transmitter. Connect to transmitter and set control cock to "reservoir". Back pressure screw all the way out. Set the control cock to "line". Turn on inverter.

Turn the pressure screw in slowly to obtain, in order, the following readings on the master gage. Record the readings, obtained on the airplane's oil pressure gages, in the table below:

Tolerance is ± 5 lbs. Circle those readings which are off tolerance.

Friction tolerance ± 3.5 lbs, which is the difference between readings taken on the "up-grade" and the "down-grade" for the same pressure.

		Eng. 1	Eng. 2	Eng. 3	Eng. 4
a.	0	0	0	0	
b.	40	40	39	40	
c.	80	73	76	78	
d.	120	110	118	115	
e.	160	155	155	153	
f.	120	120	130	123	
g.	80	76	80	83	
h.	40	40	40	43	
i.	0	0	0	0	

III. FINAL INSTRUCTIONS

Turn pressure screw all the way out
Set control cock to "reservoir".
Turn pressure screw all the way in.
Remove test unit line from transmitter and replace unit in C-1.
Allow pointers on gages to return to 0 before turning inverter off.
NOTE: Wipe up all oil which may have leaked out during tests.

IV. PERFORM 50-HOUR INSPECTION and record results on form 41B.

V. REMOVAL AND INSTALLATION

In case of a defective instrument, consult your instructor regarding removal and replacement.

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TEMPERATURE GAGES
A. CYLINDER HEAD TEMPERATURE GAGES

References: 05-1-8, 05-40-3

I. PURPOSE AND TYPE

To measure and indicate the temperatures of the engines at cylinder head No. 5. Thermocouple transmitters and galvanometer indicators are employed to perform this function

II. PROCEDURE

1. Preliminary Instructions: Use thermocouple tester. Disconnect positive thermocouple lead from cylinder head gage. (For instructional purposes the positive lead is left disconnected on mock-up). Never disconnect negative lead from the ship's gage for this test. See that it is tight. Adjust pointer reading on ship's gage to 20° C. (Tap gently). Connect red clip of tester lead to plus post of gage on airplane. Connect black clip of tester lead to the disconnected positive thermocouple lead. Connect other ends of leads to tester as follows: Red to red post, and black to 8 ohm post. Set the zero of the test meter to 20° C. Turn on battery with rheostat knob. Turn selector switch to 350° position. Adjust rheostat to get a pointer reading of 350° on tester, and do not change this setting of the Rheostat while taking all the readings for this thermocouple.

2. Tests: Read cylinder head gage at each indicated setting of selector switch. (Tap gently). Tolerance ± 10° C. Circle the readings which are off tolerance.

	REPORT YOUR READINGS FOR				
	Eng. 1	Eng. 2	Eng. 3	Eng. 4	
a. 350		399	350	325	
b. 300		299	300	285	
c. 250		250	250	240	
d. 200		201	202	193	
e. 150		152	157	149	
f. 100		101	105	100	
g. 50		50	55	50	
h. 20		21	30	22	

3. Final Instructions: Remove tester leads and replace them in the tester compartment. Adjust cylinder head gage to cockpit free air thermometer reading. Return the tester to C-1 set.

4. Record the results of the above 50-hour inspection on your form 41B.

5. Consult your instructor before removal or replacement of defective instrument.

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TEMPERATURE GAGES
B. OTHER TEMPERATURE GAGES

References: Air 05-40-16, Oil 05-40-12

I. PURPOSE AND TYPE

a. The oil temperature gage is used to give the temperature of oil just before entering the engine. It is Ratiometer Mechanism wherein the bulb is a variable resistance.

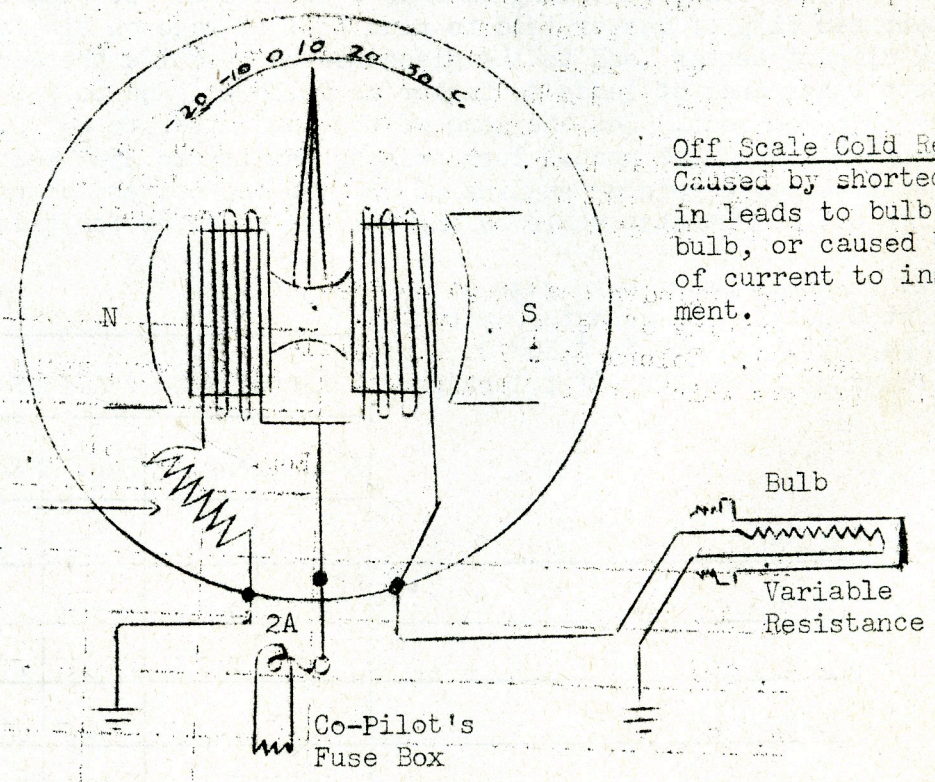
b. The free air temperature gages are of Bi-Metallic spring type. The pilot's temperature gage and the bombardier's gage are of this type.

c. The carburetor air temperature gages are of the Ratiometer Mechanism and they give the co-pilot an indication of the temperature of the air entering the carburetor so that he may better employ regulating devices to prevent icing of the carburetor or detonation of the engine.

RATIOMETER MECHANISM

Full Hot Reading:

Caused by burnt out bulb or broken leads to bulb.



Off Scale Cold Reading:

Caused by shorted wires in leads to bulb or in bulb, or caused by lack of current to instrument.

Record Temperature Readings as Follows:

Carburetor Air Temperature: (Should agree with Free Air Temperature when engines are cold.)

Engine #1 _____ Engine # 3 _____
Engine # 2 _____ Engine # 4 _____

Oil Temperature: (Should agree with Free Air as above.)

Engine # 1 _____ Engine # 3 _____
Engine # 2 _____ Engine # 4 _____

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GYRO INSTRUMENTS AND VACUUM GAGES

Reference: T.O. 05-1-8, 05-20GB-1, 05-20AB-1, 05-20HB-1, 01-5EC-2.

I. PURPOSE AND TYPE

The gyro instruments are the Turn Indicator (Directional Gyro), Flight Indicator (Artificial Horizon), and Bank and Turn Indicator (Rate of Turn).

Each of these instruments contains a gyroscope wheel upon which its operation depends. The gyro wheel is turned by a stream of air which exhausts to a vacuum. These instruments are necessary for blind flying.

II. GYROS AT REST CHECK

1. Check pointer on Bank and Turn Indicator for "zero" position.
   (Tolerance 1/64 inch)----Results_____
2. Check the caging knob of the Turn Indicator for freedom of movement and operation of dial. ----------Results_____
3. Check the caging knob of the Flight Indicator for operation and locking in the "on" and "off" position.---Results_____
4. When Flight Indicator is caged (In "off" position), the horizon bar and amount of bank indicator should line up exactly with their "zero" marks. (Tolerance Zero)---------Results_____

III. OPERATIONAL CHECK

Use C-1 to operate gyros. Attach large hose from C-1 to connection "A" outlet and to vacuum line of ship (between relief valve and pump). Attach portable suction gage from the C-1 to the back of the Bank and Turn Indicator if it is not already attached.

Turn controls of C-1 to "Vacuum", "Gyro", "Pump Drive" and set control valve to "off". (Caution: Control Valve is a needle valve and must not be forced). Turn on "AC Motor". Vary motor speed to get 4 inches of Mercury on Pilot's suction gage. Warning: If speed control begins to run slightly tight, quit turning in that direction. It is sometimes necessary to adjust relief of engine vacuum line on actual ship test.

Adjust restriction on Bank and Turn line to give reading of 2 inches of Mercury on attached portable gage when Pilot's gage shows 4 inches Hg.

Allow five minute run to get up speed of gyros.

1. Check pointer on Bank and Turn Indicator for "zero" position.
   (Tolerance 1/64 inch)-----Results_____
2. Set the Turn Indicator (Directional Gyro) to 180 degrees by means of caging knob and then "uncage" the Turn Indicator by pulling the knob out. Let gyro run in this position for 15 minutes.
   Read the amount of "DRIFT" or movement from the 180 degree heading.----------Results_____.
   (Tolerance plus or minus 3 degrees DRIFT)
3. Uncage Flight Indicator (In "on" position) and let run for 15 minutes.
   -----Be sure ship is in level position while doing this.----
   Why is a level position necessary?_____
   _____
   During the 15 minutes the horizon bar and bank indicator should stay on the "zero" position.
   (Tolerance plus or minus 1/64 inch)
   Results_____.

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GYRO INSTRUMENTS AND VACUUM GAGES (Cont'd.)

4. Make 8 minute Coast Test:
Cage Turn Indicator and Flight Indicator. Turn off C-1 let gyros coast. All three gyros should coast at least 8 minutes. If gyros do not coast 8 minutes, they should be replaced.

Results:
Bank and Turn _____.
Turn Indicator _____.
Flight Indicator _____.

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PITOT - STATIC SYSTEM AND INSTRUMENTS, AND MANIFOLD PRESSURE GAGE

Reference: T.O. 05-1-8, 05-1-31, 05-20-17, 05-30-3, 01-5EC-2.

I. PURPOSE AND TYPE

Altimeter (Aneroid Mechanism)
To indicate the elevation of an aircraft above a point on the ground, regardless of elevation of point, and to indicate elevation of aircraft above sea level.

Rate of Climb (Diaphragm Mechanism)
To show the rate of climb or rate of dive regardless of the altitude of the airplane.

Air Speed (Diaphragm Mechanism)
Indicates the rate of speed at which the airplane is traveling through the air.

Manifold Pressure Gages (Aneroid Mechanism)
To show manifold pressures under various engine operating conditions when the engines are equipped with superchargers.

II. PRELIMINARY INSTRUCTIONS

Remove the sock from the Pitot Head on L.H. Side of ship, Station 0.3. Slip Pitot fitting over the Pitot tube. Attach small hose to the Pitot fitting and to "B" connection on C-1. Turn controls of C-1 to "pressure", "Airspeed", "Pump Drive", and turn "Control Valve" to "off".

III. TESTS OF PITOT ASSEMBLY

1. Pitot line leaks.
   Turn AC Motor "on" and open control valve to get reading of 150 m.p.h. on the C-1 Air Speed Indicator. Turn control valve "off" and turn "off" the AC Motor.
   Record the drop in reading of the Airspeed Indicator after a one minute interval. Drop in reading _____ m.p.h.
   (Tolerance is 10 m.p.h. in one minute.)
2. Airspeed Operation;
   By operating the control valve, obtain the following readings on the C-1 Airspeed indicator and record the readings of the airplane's Airspeed indicator: 0_____ 50_____ 100_____
   150_____ 200_____ 250_____ 300 295.

IV. CHANGE-OVER INSTRUCTIONS

Remove Pitot fitting and replace in C-1. Two Static discs, with small holes to allow atmospheric pressure to enter Static lines, are located on both sides of airplane in line with the nose wheel. Seal both of them with masking tape. Connect the small hose from the C-1 "B" outlet to the bottom of a Static line "DRAIN TRAP" located in the nose compartment, near the Bombardier's Switch Panel. Turn control of C-1 to "Vacuum", "Airspeed", "Pump Drive", "AC Power", and turn "Control Valve" to "off".
(Caution: Control valve is a needle valve with a lead seat and must not be forced.)

PITOT - STATIC SYSTEM AND INSTRUMENTS, AND MANIFOLD PRESSURE GAGE (Cont'd)

V. TEST OF STATIC LINE ASSEMBLY

A. Static Line Leaks
a. Adjust pointers of altimeter to 0.
b. Turn AC Motor to "ON".
c. Open control valve slowly, watching altimeter on airplane and when it reads 1000 feet.
d. Turn "OFF" control valve and turn AC Motor "OFF".
e. Record drop in readings of altimeter after one minute.
drop in Reading _____ feet.
(Tolerance is 150 ft. in one minute.

B. OPERATION OF INSTRUMENTS

In the above test, (a) Did the rate climb indicator show climb? _____
(b) Did air speed indicator show change in speed? _____

VI. A. ALTIMETER CHECK
a. Check zero setting: Turn reference markers, triangular marks, of both the Master Altimeter and the Pilot's Altimeter to zero.
Record reading of Pilot's of barometric scale _____
(should be 29.92). If not, remove and replace altimeter.
Reading of pointers on Master Altimeter _____
Reading of pointers on Pilot's Altimeter _____
b. Place Master Altimeter at same level as Pilot's Altimeter. Set pointers on both altimeters to 0.
Read barometric scales:
Master Altimeter _____
Pilot's Altimeter _____
Tolerance is .02. If not adjust altimeter to make Master and Pilot's altimeter read the same.

B. MANIFOLD PRESSURE GAGE CHECK
a. Record readings of manifold pressure gages:
Eng. 1 _____ Eng. 2 _____
Eng. 3 _____ Eng. 4 _____
(In older models turn on Inverters)
Altimeter reading from (b) above _____ (Station Barometer)
Manifold Pressure gage readings should agree with Barometric Pressure to within 0.4 Hg. (Also, see tolerances on page 79)

C. FINAL INSTRUCTIONS

Remove and replace Pitot fittings in C-1.
Replace socks on Pitot-static heads.
Coil and make hose in C-1.

VII. INSPECTION

Perform the 50-hour inspection on these instruments and record results in form 41B.

VIII. REMOVAL AND REPLACEMENT

In case of a defective instrument, consult your instructor about removing and replacing.

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INSTRUMENT SCHEMATIC CIRCUITS

Use the Schematic Prints for the instrument circuits to obtain the information needed for the following: (Under no circumstances should you use the mock-ups; for this use schematics)

I. Identify the following harnesses by telling (1) what engines they serve, and (2) between what structural disconnects they are located.

a. No. 12521 _____.
b. No. 20062 _____.
c. No. 12617 _____.
d. No. 20414 _____.

II Report the harness numbers for fuel pressure, Engine No. 1, from

a. Transmitter to Junction Box No. _____.
b. Junction Box to Firewall No. _____.
c. Firewall to Wing Disconnect No. _____.
d. Wing Disconnect to Pilot's Disconnect No. _____.
e. Pilot's Disconnect to Indicator No. _____.

III. Suppose you are checking the continuity of the oil pressure circuits from Engines 1 and 2. Show which terminal of the indicator cannon plug should give continuity to each of the transmitter terminals named:

Transmitter Terminals		Indicator Terminals (State "Letter")
Engine 1.	A.	_____
	B.	_____
	C.	_____
	D.	_____
Engine 2.	A.	_____
	B.	_____
	C.	_____
	D.	_____

CONCLUSION: Is the Fuel Pressure autosyn unit for engines 1 and 2 similarly connected? _____.
How about engines 3 and 4? _____.

IV. Copy the schematic circuit of any one of the oil temperature gages. Point check the above circuit at the following locations

1. Co-pilot's fuse box _____ Volts
2. Q-strip on station 1.1 _____ Volts
3. Engine Junction Box _____ Volts

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INVERTERS

Reference: T.O. 03-5-21, 03-5H-2, 03-5H-3, 03-5H-5, 03-5H-7, 03-5H-8, 03-5H-9

I. PURPOSE, TYPE AND LOCATION

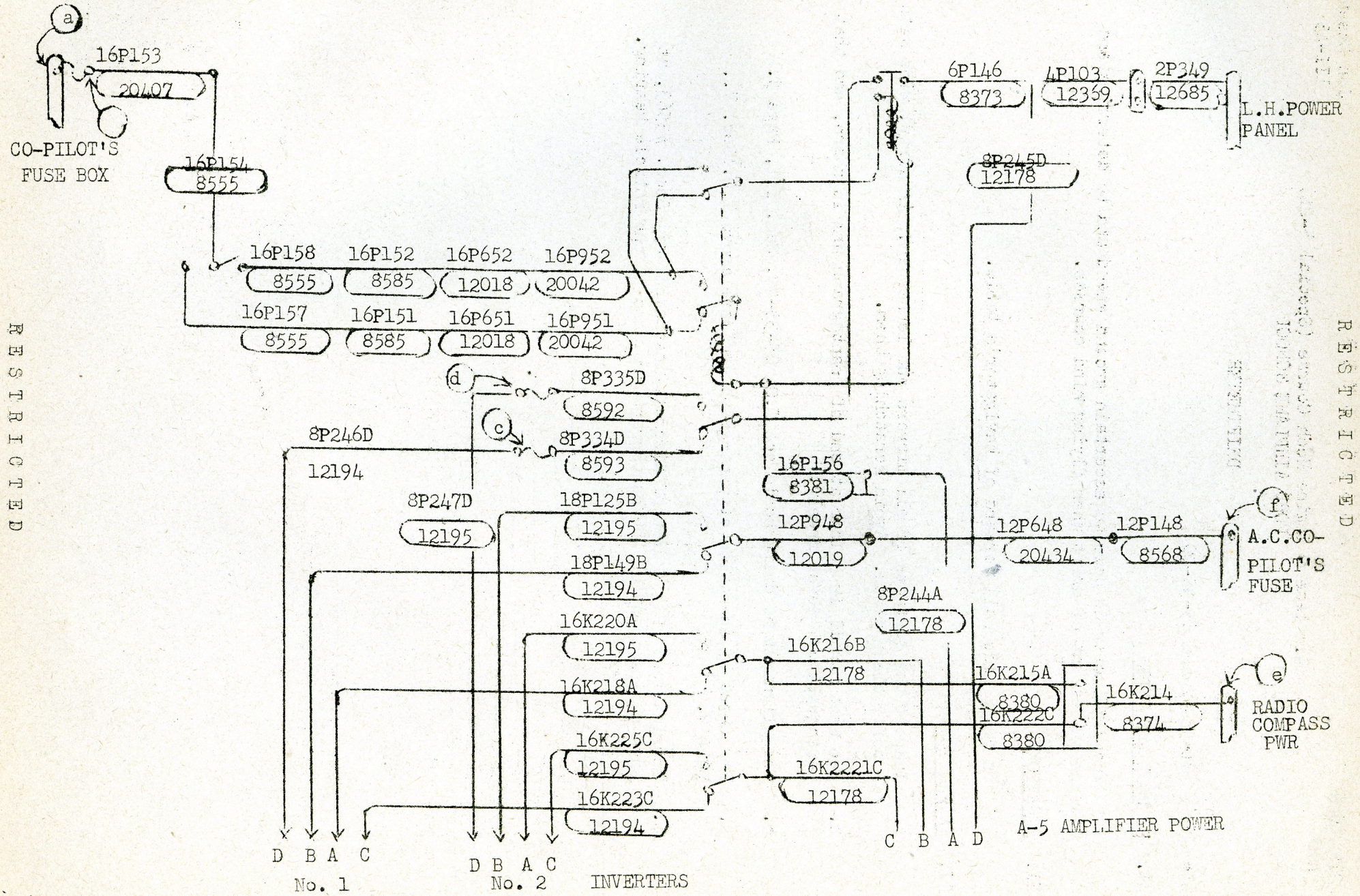
The alternating current for operating the autosyn instruments, radio, compass are supplied by two AC inverters, operated one at a time.
ALWAYS TURN ON INVERTER BEFORE STARTING ENGINES.
The same inverter is always used in flight -- leaving other inverter as reserve.

II. REMOVAL AND REPLACEMENT

In case of defective parts or units consult your instructor before removal and replacement.

Voltage Output Check of Inverters is made in Inverter Relay Junction Box. Terminal #3 to ground gives 26 V. A.C. Terminals #2 and #1 to ground gives 115V. A.C. when A-5 Automatic Pilot is used on ship. Terminal 2 to ground gives 115 V. A.C. when C-1 Autopilot is used on ship. If Voltage is not correct, consult table below for adjustment:

Make & Type	Voltage	Voltage & Cycle Regulation
General Electric Inverter Model 5AT121JJ2B 3 phase Type for A-5 Automatic Pilot	26 V. A.C. Single Phase 115 V. A.C. 3 Phase, 400 cycle	Voltage adjustment made by sliding adjustable resistor up and down. (Found in box on inverter Cycle adjustment is made by adjusting contacts inside the housing on the motor end. See T.O. AN03-5H-7, Page 18 and 19 for details.
Ieland Electric Inverter Type 800 VA 3 phase Type for A-5 Automatic Pilot	26 V. A.C. Single Phase 400 cycle 115 V. A.C. 3 Phase 400 cycle	Voltage Adjustment is made by sliding adjustabl resistor up and down. (Found in box on top of inverter.) Cycle Adjustment should not require readjustment.
Holtzer-Cabot Inverter Type MG-153 3 phase Type for A-5 Automatic Pilot	26 V. A.C. Single Phase 115 V. A.C. Three Phase 400 cycle.	Voltage Adjustment is made by slide wire resistor found in box on inverter. Cycle Adjustment is made by moving wire contact on Terminal Board with 4 terminals. No. 1 gives maximum; No.4 gives minimum.
Holtzer-Cabot Inverter Type MG-149F Single Phase Type for C-1 Autopilot use	26 V. A.C. Single Phase 400 cycle 115 V. A.C. Single Phase 400 Cycle	Voltage Adjustment. Inverter has a two position switch having Hi-Lo position. Safetied in Lo Position for ½ load. If voltage drops use Hi Position. Speed Governor Assembly found on end of inverter has an adjustment which is turned to right decreases cycles and if turned to the left it increases the cycles or frequency.


a
16P153
20407
CO-PILOT'S FUSE BOX
16P154
8555
16P158
8555
16P152
8585
16P652
12018
16P952
20042
16P157
8555
16P151
8585
16P651
12018
16P951
20042
d
8P335D
8592
c
8P334D
8593
8P246D
12194
8P247D
12195
18P125B
12195
18P149B
12194
16K220A
12195
16K218A
12194
16K225C
12195
16K223C
12194
D B A C
No. 1
D B A C
No. 2
INVERTERS
6P146
8373
4P103
12369
2P349
12685
L.H.POWER PANEL
8P245D
12178
16P156
8381
12P948
12019
12P648
20434
12P148
8568
f
A.C.CO-PILOT'S FUSE
8P244A
12178
16K216B
12178
16K215A
8380
16K222C
8380
16K214
8374
e
RADIO COMPASS PWR
16K2221C
12178
C B A D
A-5 AMPLIFIER POWER

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DRIFTMETER

Reference: 01-5EC-2 and 05-35-20

I. PURPOSE AND TYPE

The driftmeter is used to ascertain ground speed and to determine and measure the amount of drift when flying wind courses.

II. LOCATION

On right side wall forward of navigator's table.

III. INSPECTION

a. Inspect the surfaces of all mirrors and lenses and, if dirty, wipe with a soft, clean cloth. Avoid scratching them.

b. See that pencil in holder at end of pantograph arm is sharp, and that pantograph arm moves freely.

c. For alignment of drift scale see T.O. 05-35-20, Sec. III, Page 5.

d. For check of operation of pantograph arm, see above T.O. Sec. V., page 7.

e. Lubrication: Put a drop of aircraft instrument oil Spec. #3563, at each moving point of the pantograph arm, and at the roticle bearing. Wipe off excess oil.

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C-1 AUTOMATIC PILOT

Reference: Manufacturers Handbook AN-11-60AA-1

Main Components: The Autopilot contains three separate electrical channels connected to one power source. These channels are referred to as "Aileron" axis, "rudder" axis, and "elevator" axis, as they conform to the three control surfaces of the plane.

Subdivision: The three main channels are similar, and each may be divided into three parts: the power system, the bridge system, and the Amplifier.

The Power System: This system consists of the following elements which do the work of the Autopilot and which are included in the low-voltage D.C. circuit:

(a) Airplane batteries. (b) Servo motors. (c) Operating solenoids and brake solenoids. (d) Brake switches. (e) Limit switches. (f) Relay contacts. (g) Erecting cutout switches. (h) Erecting cutout magnet. (i) Directional Arm locking solenoid. (j) Directional Arm Lock switch. (k) Two gyro motors. (l) Rotary Inverter--D.C. driven. (m) Tell-tale lights. One light for each relay; indicates when the relay closes.

The Bridge System: The bridge system is the source of the signals controlling the power system. It is made up of a number of potentiometers (pots) and the transformers supplying their voltage. In contrast to the power system, the bridge system uses A.C. for power. The alternating voltage for all three bridge circuits is supplied by two transformers located in the amplifier.

The bridge system of any one channel consists of the following:

(a) Main or pickup pot. (b) Balance pot. (c) Centering pots. (d) Fixed and variable ratio resistors. (e) Compensation pots--bank pot, skid pot, and up elevator pot. (f) Compensation controls--bank trimmer, skid trimmer, and up elevator trimmer. (g) Turn Control pots with their trimmers.

The Amplifier: The Amplifier is an electronic circuit which amplifies the signals from the bridge system, and translates them into electrical impulses which control the operation of the Servos in the power system by energizing the Servo operating solenoids. The division between the Amplifier and each bridge system is at the "J" box, where one single lead from each bridge circuit carries all the signals from the complete circuit to the grid of the first Amplifier tube. The division between the Amplifier and the power system is at the relays; the relay coils are part of the Amplifier, while the relay contacts are part of the power system.

PRE-FLIGHT INSPECTION:

1. Make sure the Turn Control (or controls) is centered and bombsight clutch on Stabilizer Gyro is disengaged (lever toward you).
2. Turn on Autopilot master switch.
3. Set all adjusting knobs on Autopilot Control Panel to "pointers up" position.
4. Disengage Autopilot clutch and center PDI on top of Stabilizer Gyro. Re-engage.
5. Turn on Servo PDI switch on Autopilot Control Panel.
6. Operate the airplane controls manually. Observe tell-tale lights and observe if they flicker. (Clean potentiometer Pot if they do.)
7. Turn on Aileron engaging switch. One light will flicker and go out as the ailerons move to streamlined position.
8. Turn on rudder and elevator.
9. Turn aileron, rudder, elevator, Autopilot clutch arm, turn control knob, and check for proper operation of the controls.

********If malfunction is detected---See Technical Orders for details.********

COMMON TROUBLES

Dirty Potentiometer resistance pots, worn pot wipers, dirty or pitted relay contacts, loose or poor contacts in cannon plugs, blown fuses, bad tube amplifier, no output from inverter, or servo motor unit trouble. Wiring may be shorted or broken. (Inverter, used for the C-1 Autopilot only, has an output of 19 V. A.C. and 105 cycle frequency)

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

WING FLAP POSITION INDICATOR (Selsyn)

I. PURPOSE AND TYPE

A selsyn transmitter and indicator are used on the B-24 to indicate the position of the wing flaps. The system is operated by 24 volts D.C. current obtained from the airplane power system.

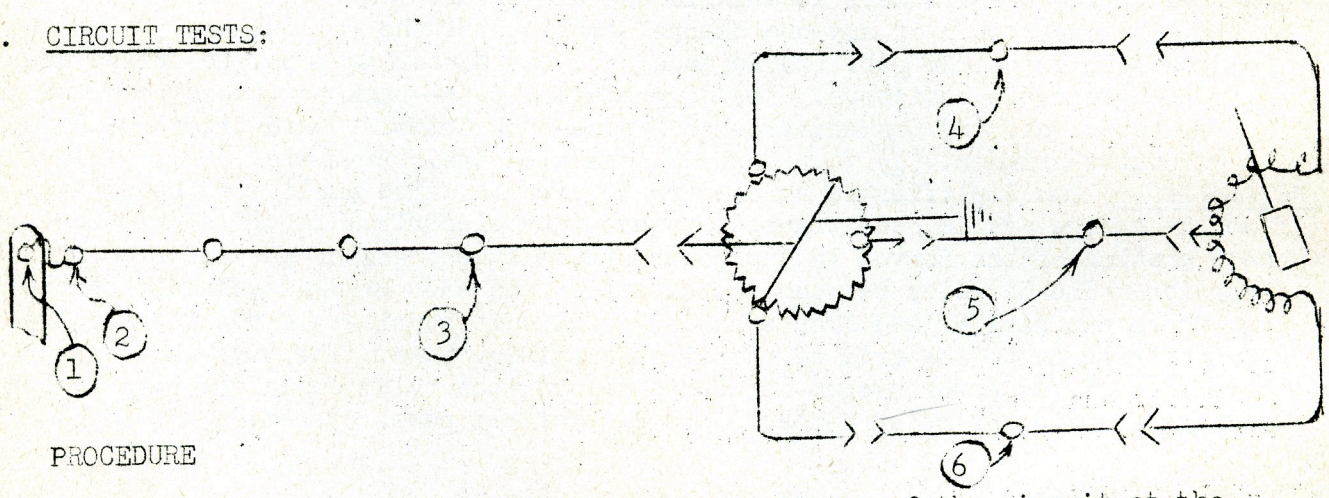
II. LOCATION

The transmitter is located on the left wing (rear spar) between nacelles number 1 and number 2. The indicator is located on the instrument panel visible to both pilot and co-pilot.

III. ADJUSTMENTS

To adjust the 40° reading the transmitter pulley is repositioned to give the proper reading of indicator. To adjust the amount of indicator travel, the pulley nut is tightened to expand the rubber disc of the pulley to decrease travel, or is loosened to increase the indicator travel.

IV. CIRCUIT TESTS:



PROCEDURE

With a 24 volt test light check the condition of the circuit at the indicated points.

Check Point	Condition.	Maintenance Required.
1.		
2.		
3.		
4.		
5.		
6.		

V. INSPECTIONS

Preflight: Check for operation and proper indication.

50-Hour Inspection: Check for proper operation and also for security of electric wiring.

Job Sheet
IV-1

ENGINE
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COWLING

A. Location

1. Seven sections of cowling and panel assemblies.
   a. Nose ring cowl. Nose sec. prop gov
   b. Wrap Cowling. Cyl & power sec
      1. Top panel and padding.
      2. Left Panel and padding.
      3. Right panel and padding.
      4. Bottom panel and padding.
   c. Cowl flaps (8 pieces). Collector ring + shroud
   d. Intermediate Cowling. accessory section
      1. Top Panel.
      2. Right side panel
      3. Left side panel.
      4. Right bottom panel.
      5. Left bottom panel.
   e. Rear Cowling. Oil tank, cooler, inner cooler, rear access.
      1. Top panel.
      2. Right, at wing.
      3. Left, at wing.
      4. Right bottom panel.
      5. Left bottom panel.
   f. Supercharger. Supercharger
      1. Right panel.
      2. Left panel.
   g. Fairing air intake screen, streamlining
      1. Nacelle upper tail.
      2. Nacelle lower tail.
2. Nose former ring.
3. Nose ring vibration absorbing neoprene insulated brackets.
4. Flap former ring.
5. Former ring on collector ring shroud.
6. Intermediate former ring.
7. Rear former ring.
8. Stringers.
9. Neoprene chafing buttons and strips.
10. Cowl flap jacks.
11. Cowl flap jack drive cable.
12. Cowl flap motor and brushes.
13. Cowl flap control box. limit-switches, and cams.

B. Questions

1. What engine parts or accessories, in general, does each cowling section cover?
2. What is one outstanding structural feature of each of the following cowling panels?
   a. Wrap, top and bottom.
   b. Intermediate, top, right bottom, and left bottom.
   c. Rear top.
3. What is the position of the cowl flaps during ground operation? open
   During flight? closed or almost
4. What would be the result of too tightly secured wrap cowling?
5. What are two defects for which cowling is especially inspected? breaks & dents fast
6. Why should cowling never be laid on the leading edge of the wing?

SYSTEMS

Job Sheet
IV-1a

Airplane & Engine Mech Course (Special B-24)
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COWLING

Col. No. Form 41B	Interval	Inspection Required	Symbol	Remarks:
	PF	1. See that all cowling is properly fastened and that all inspection doors and covers are secured. Check each dzus fastener for locked position.	/	General loose dzus fasteners
	D	2. Remove all engine cowling except the nose rings and cowl flaps, and check for general condition especially cracks and loose dzus fasteners. Check the condition of the baffle padding on the wrap cowling	/	Some cracks & loose dzuses
	D	3. Inspect ring cowling for security of attachment, distortion, loose rivets, cracks, and broken braces.	M	
	D	4. Inspect all former rings and stringers for:		
		a. Security of mounting		
		b. Loose rivets and Phillips screws.		
		c. Condition of neoprene chafing buttons and strips.	/	Buttons missing
	D.	5. Inspect nacelle upper tail fairing for security of attachment.	M	
	D	6. Inspect cowl flap cables for proper attachment and condition.	M	
	D	7. Inspect cowl flap jacks for proper attachment safetying, and condition.	M	
	D	8. Inspect the sliding part of the jack for grease and wipe clean, if necessary.	M	
		9. Cowl flap motor. T.O. 01-5EC-2, 03-5EC-2.		
	100	a. Check for security of mounting.	M	
	100	b. Check casting for cracks or breaks.	M	
	100	c. Check condition of nuts, screws, and safetying.	M	
	100	d. Check ringnut holding connector plug in receptacle to see that plug is in place and the ringnut tight.	M	
	100	e. Check travel of mechanism to see that cams and limit switches are functioning properly.	/	Less than full travel
		f. Set the position of cowl flap as directed by the instructor. See Instructor	M	
	50	10. Lubricate cowl flap hinges (16 places) with Aircraft Instrument Oil, Army Spec. 2-27	M	
	50.	11. Lubricate Wrap cowl hinges (6 places) with Aircraft Instrument Oil, Army Spec. 2-27.	M	

Job Sheet
IV-2

Airplane & Engine Mech Course (Special B-24)
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ENGINE
SYSTEMS

AIR INDUCTION SYSTEM

A. Locations and Functions

1. Nose ring
2. Right Air Duct.
3. Generator Blast Tube.
4. Magneto Blast Tube.
5. Flex Joint Blast Tubes.
6. Screen in R. Air Duct.
7. Damper Duct, Gate and Slot.
8. Neoprene Bellows.
9. Carburetor Air Filter (Alternate Supply).
10. Intercooler Motor and Shutters.
11. Intercooler.
12. Left Air Duct.
13. Carburetor Air Scoop.
14. Snake Duct.
15. Intake Pipe
16. Manifold Pressure Autosyn transmitter, take off, line & fitting.
17. Carburetor Air Temperature Bulb.
18. Cylinder Head Baffles.
19. Spark Plug Blast Tube.

B. Questions

1. What is the purpose of 2 blast tubes in tail stack shroud? Cool flex joint
2. What would happen if you had a leak in an exhaust pipe directed at an intake pipe? fire
3. What is the purpose of the upper part of the right air duct? Carburetor
   lower part? R mag, flex joint, gen, oil cooler
4. What is the purpose of the SNAKE DUCT? Sup chg bearing case
5. Why is the inside edge of the air intake duct at the nose ring cowling undercut in relation to the outside edge? Scoop more air
6. What effect would an opening in the upper part of the right air duct have? Reduce critical altitude.
7. What is the purpose of the gate in the upper right air passage? The air filter?
8. What is the purpose of the baffles in the carburetor air scoop? Even mixture
9. Will an air leak between the supercharger and carburetor have any effect on fuel air ratio? No
10. How are the intake pipes made leak proof? neoprene gaskets
11. From what section of the engine is mixture led to the intake pipes? Blower
12. What purpose do engine cylinder baffles serve? Directs cooling

ENGINE systems

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Airplane & Engine Mech Course (Special B-24)
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AIR INDUCTION INSPECTION

Col.No. Form 41B. Interval	Inspection Required	Symbol	Remarks:
D	1. Inspect air ducts for security of attachment, evidence of failure, cracks, and loose dzus fasteners.		
D	2. Inspect the following for security of mounting, clogging of passages, cracks, cuts, or abrasions, presence of oil, and loose bolts, nuts, or dzus fasteners.		
	a. Neoprene bellows on all air ducts.		
	b. Magneto blast tubes.		
	c. Generator blast tube.		Not comm
	d. Flex Joint blast tubes.		" "
	e. Air ducts.		
	f. Air Scoop.		
	g. Nose ring.		
	h. Damper duct.		
	i. Snake duct.		
	j. Cylinder baffles.		
D	3. Inspect damper gate and controls for functioning, operating range and tightness.		
D	4. Remove and inspect all air filter elements for contamination. For cleaning refer to T.O. 01-5EC-2, p. 53.		
D	5. Inspect intake duct below the frame of the air filter for evidence of oil from filter, element. If necessary, clean duct with gasoline.		
D	6. Inspect hinged flap in duct forward of frame for freedom of motion and proper seating. CAUTION:--Under extremely dusty conditions, inspect and clean all carburetor air filters after each flight.		
PF	7. See that intercooler shutters operate correctly (Ask instructor about new intercooler shutters.)		
25	8. Inspect packing gland nuts on intake pipes for evidence of leakage.		
50	9. Check intake pipes for dents, punctures distortion, and security of mounting.		
50	10. Check connection in air scoop of Carburetor Air Temperature Indicator for security of mounting and damage.		
50	11. Disconnect Manifold Pressure Autosyn gage transmitter line at the transmitter and blow accumulated condensation into engine blower case (T.O. 01-5EC-2 p.82). Later ships in the H & J series have a line running the manifold pressure directly to the instrument in the cock-pit. Shut-off valves for these lines are located at the left foot pedal of the pilot and right foot pedal of the co-pilot.		

Job Sheet
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ENGINE
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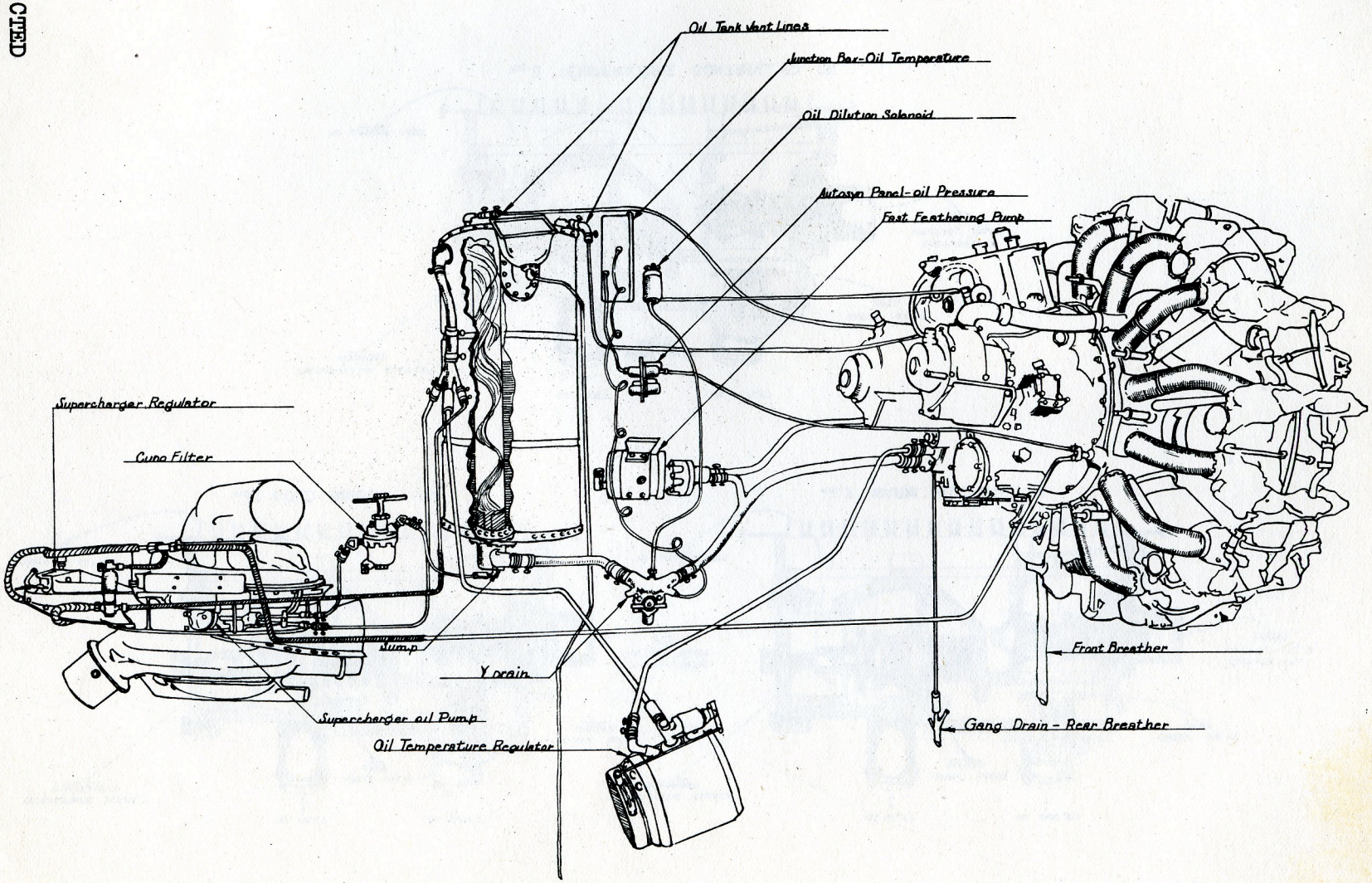
Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

AIR INDUCTION INSPECTION

Col.No. Form 41B.	Interval	Inspection Required	Symbol	Remarks:
	50	12. When warming up engines with such a set-up, these valves will be open for a few seconds to clear the line of liquid and vapors. This is done at idling speed so that an in-flow of air through the vent line will force vapor and condensation out of the line into the engine. If the shut-off cock is opened at engine speeds producing a manifold pressure greater than atmospheric pressures, successful draining is not accomplished (T.O. 02-1-29 Sec. III, 7).		
	50	13. Check cylinder head baffles and spark plug blast tubes for obstructions, cracks, dents, and security of mounting.		



NACELLE OIL SYSTEM

5/13/43

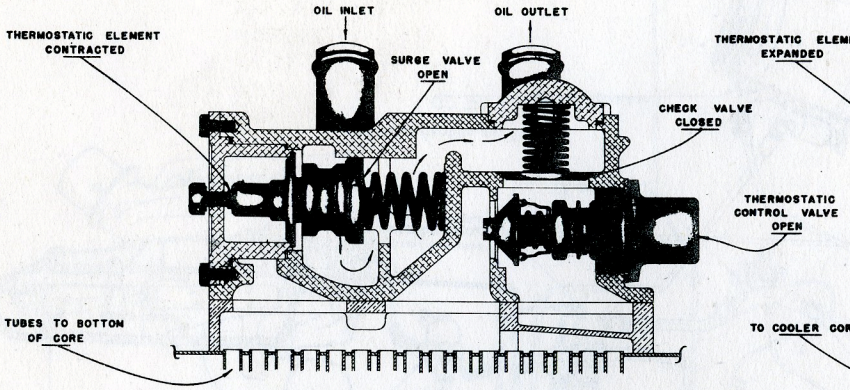


FIG. 1 COLD INCOMING OIL

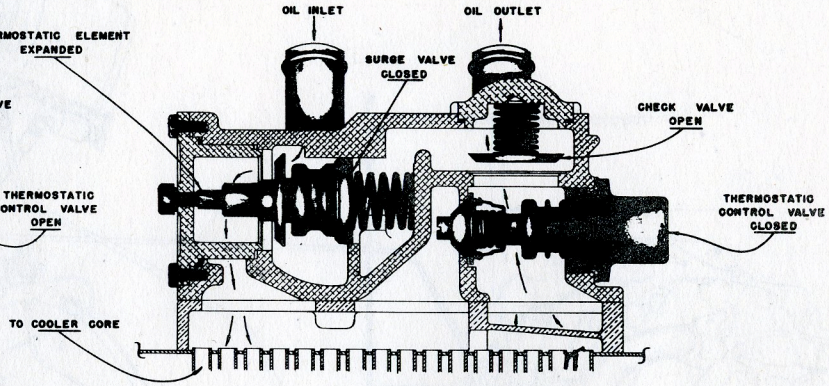


FIG. 2 WARM INCOMING OIL

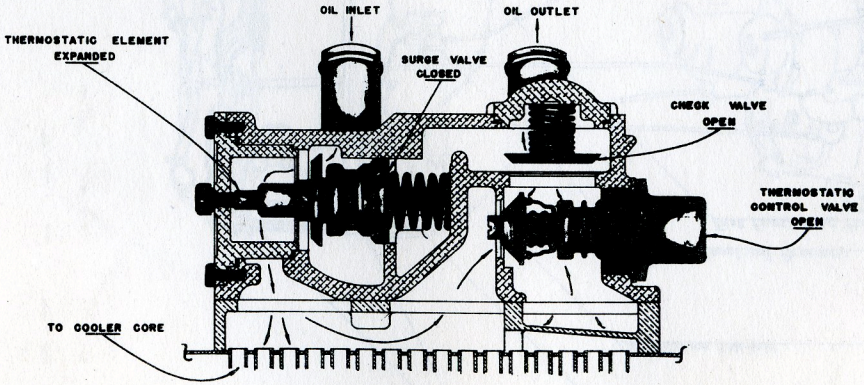
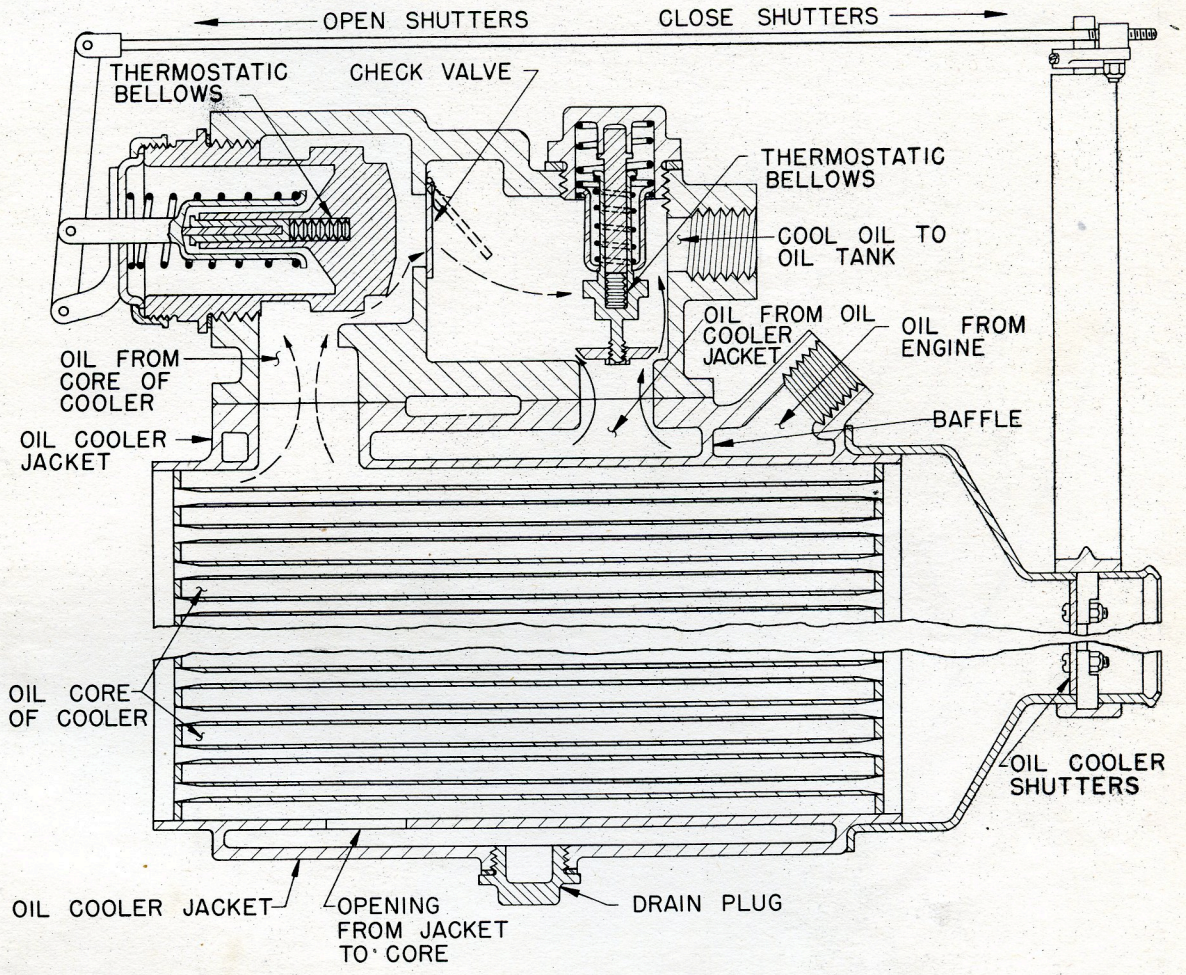


FIG. 3 TEMPERATURE CONTROLLED OIL

OIL SURGE VALVE AND OIL TEMPERATURE REGULATOR VALVE

ALLMAND 73-44



SCHEMATIC DIAGRAM OF OIL TEMPERATURE REGULATOR

Figure 48B

Airplane & Engine Mech Course (Special B-24)
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OIL SYSTEM INSPECTION SHEETS

Location and Function

Locate each unit listed below and be able to state its function.

1. Oil tank
   - a. Filler Cap
   - b. Scupper and Drain
   - c. Inspection Plate
   - d. Vent necks.
   - e. Oil-in Connection
   - f. Hold down clamps
   - g. Strap
   - h. Padding
   - i. Sump
   - j. Oil-out Connections
2. Y-drain
   - a. Drain cock
   - b. Oil dilution inlet
   - c. Oil temperature bulb connection
3. Fast feathering pump
   - a. Relief Valve
   - b. Inlet and Outlet lines
4. Oil inlet line to engine L Rear acc sec
5. Oil pressure pump L Rear acc sec
6. Main oil screen R Side bottom acc sec
7. By-pass valve just above ↑
8. Alternate oil temp. Connection y-drain
9. Thermostatic time delay control ass'y.
10. Compensating oil pressure relief valve.
11. Oil pressure gage connection
    - a. Oil press. gage line to autosyn
12. Oil pressure autosyn transmitter "
13. External oil pressure line to front power section
14. Main Sump
    - a. Drain plug
    - b. Screen
15. Rocker Box sump
16. Rocker sump scavenge and breather pipes
17. Nose section scavenge pump
18. External scavenge pipe from nose scavenge pump
19. Front breather L Nacc sec Y-com
20. Rear breather " " " "
21. Oil tank lines and connections
22. Fast feathering line, pump to governor.
23. Auxiliary high pressure oil outlet RNS
24. Auxiliary low pressure oil outlet "
25. Accessory section drain plug and screen
26. Oil out-line to oil temp. regulator.
27. Oil temperature regulator
28. D-8 thermostatic valve
29. Turbo-supercharger Cuno
30. Oil inlet connection to turbo top
31. Oil outlet line from turbo bottom
32. Line from turbo to oil tank
33. Pressure line to turbo regulator
34. Turbo regulator relief valve.
35. Turbo regulator inlets
36. Turbo regulator outlet
37. Turbo regulator return line to tank.
38. Oil dilution solenoid
39. Fast feathering solenoid Junc box R.H.S.
40. Inter-cylinder rocker box oil drain.
41. Inter-ear cylinder rocker box oil drain.

SYSTEMS

Airplane & Engine Mech Course (Special B-24)
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OIL SYSTEM INSPECTION SHEETS

Col.No. Form 41B	Interval		Inspections required	Symbols	Remarks:
	50	1.	Inspect oil tank for: (T.O. 01-5EC-2)	m	
			a. Security of mounting		
			b. Signs of leakage		
			c. Condition and proper location of padding.		
			d. Proper tension of supporting straps.		
			e. Proper anchorage of oil lines leading to and from the tank.		
	PF	2.	Check for evidence of deterioration of self sealing oil tank. (01-5EC-2)	m	
	PF	3.	Check the amount of oil in the tank using a dip stick and allow 1" = 1 gal. (If oil is added, on an installation, the quantity is entered, in quarts, on the Airplane Flight Report, Form No.1A)	m	1.5 gal
	PF	4.	Secure the tank cap and safety.	m	
	D	5.	Inspect the oil tank drain cock for tightness and proper safetying.	m	
	25	6.	Inspect all the oil lines for leaks, security of anchorage, wear due to chafing or vibration, dents or cracks, and general condition, from:	m	
			a. Tank to Y-drain.	m	
			b. Y-drain to engine and fast feathering pump.	m	
			c. Right front of blower section to front of power section.	m	
			d. Rocker sump to nose pump.	m	
			e. Nose pump to forward left hand side of blower section.	m	
			f. Fast feathering pump to prop governor.	m	
			g. Main oil pump to oil temp. regulator.	m	
			h. Oil temp. regulator to tank.	m	
			i. Engine to turbo regulator.	m	
			j. Turbo regulator to tank.	m	
			k. Oil pressure gage connection to autosyn	m	
			l. Tank to Cuno.	m	
			m. Cuno to turbo.	m	
			n. Turbo to tank.	m	
	25	7.	Inspect all connections for leaks, wear due to chafing, proper tightness of clamps (T.O.03-1-29) tightness of nuts, condition at:	m	
			a. Tank.		
			b. Y-drain.		
			c. Engine "in" and "out"		
			d. Feathering pump "in" and "out" and connection at prop governor.		
			e. Oil pressure gage connection.		
			f. Other oil line connections on engine.		
			g. Oil temperature regulator.		
			h. Turbosupercharger.		
			i. Turbo supercharger regulator.		
			j. Oil pressure autosyn		
			k. Turbo supercharger Cuno.		
			l. Inter-cylinder drains.		
			m. Line from oil temp. regulator to tank.		

Airplane & Engine Mech Course (Special B-24)
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OIL SYSTEM INSPECTION SHEETS

Col. No. Form 41B. Intervals	Inspections Required	Symbols	Remarks:
25	8. Inspect for leakage, condition of gaskets, and tightness of nuts on: a. Compensating oil pressure relief valve b. Oil Pump. c. Rocker box covers. d. Sumps. e. Main oil screen cover		
25	9. Inspect for dents, security of anchorage, clogging, tightness of connections, kinks, and general condition of: a. Front breather. b. Rear breather. c. Scupper drain.		
25	10. Inspect the Y-drain for: a. Security of mounting. b. Evidence of leakage. c. Proper safetying. d. Proper connections.		
25	11. Inspect main oil screen. Drain oil from main screen chamber by removing plug from cover. Remove and clean main oil screen. a. Inspect for breaks, tear, condition of check valve and tension of spring. b. Inspect neoprene seal for condition also gasket on cover plate. c. Check by-pass valve for tension of spring by inserting hand into screen chamber and pressing on valve with finger. d. Replace drain plug in cover and safety before installing. Check with instructor for proper installation of screen, retaining, and cover. Also see T.O. 02-10CB-2 page 38. Instructor initial		
D	12. Turn the handle of the Cuno Filter, in each supercharger oil line, one complete revolution.		
25	13. Remove and clean oil Cuno filter in turbo line. Check for leakage and security after replacement. Instructor's Initial.		
D	14. Inspect compensating relief valve for leakage at connection and proper safetying.		
25	15. Sumps a. Check main and rocker box sumps for leaks, cracks, security, and proper safetying. b. Drain main and rocker sumps by removing drain plugs. Inspect main sump plug for accumulation of metal particles. Pass finger over screen to check for metal particles. Insert finger into drain hole of rocker sump and feel on each side of		

ENGINE SYSTEMS

Job Sheet IV-3c

Airplane & Engine Mech Course (Special B-24)
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OIL SYSTEM INSPECTION SHEETS

Col.No. Form 41B Interval	Inspections Required	Symbols	Remarks:
	suction pipe for sludge and foreign particles. Show plugs to instructor before installing and safetying.		
D 16.	Oil temperature regulator. T.O. 03-15-9		
	a. Inspect mounting and valve attaching bolts for tightness. Check all connections, including drain plug, for tightness.		
	b. Inspect for clogging of cores, dents and leaks. (In shutterless coolers, do not mistake dummy plugs in cores for a clogged condition.)		
D 17.	Check the turbo regulator for attachment of oil pressure and drain lines, tightness of external connections, faulty gaskets and oil seals which could permit oil leakage.		
D 18.	Inspect the fast feathering pump for security of mounting and evidence of leakage at connections. Check for proper safetying at connections and at relief valve.		
S 19.	Fill the oil pressure gage line with hydraulic fluid. T.O. 05-70-6.		

Your instructor may ask you the following questions:

1. At what interval is the main oil screen removed and cleaned? 25 hr
2. What is the capacity of the self-sealing oil tank? 32, 42
3. What is the function of the compensating oil pressure relief valve? comp different pressure for temp
4. At what temperature does the thermostatic time delay control valve open? 40 C
5. Where and how is adjustment made for the oil pressure? Comp relief v.
6. What is the purpose of the by-pass valve in the oil screen chamber? clogged screen
7. Trace the turbo lubrication system. tank - cuno - turbo pump - sprayed on bearings, etc.
8. Be able to explain the function of the oil temperature regulator.
9. What is the purpose of oil dilution? Outline the procedure. easy starting
10. How may a sluggish oil pressure gage reading be remedied during cold weather?
11. Trace the fast feathering line from tank to pump. Is it the same on all models of B-24 airplanes? No See #3901 nacelle, engine 6, 7, 18 and 19.
12. Why were the breather pipes rerouted to the left intermediate cowling on B-24-J and later airplanes? To get rid of low pressure area See #3901 nacelle, engines 6, 7, 18 or 19.
13. What is the purpose of venting the main sump to the left oil tank vent connection on the engine? See #3901 nacelle, engines 6, 7, 18 or 19.
14. What is the normal oil pressure range? 75-90 temperature range? 60-75
15. Explain correct replacement method for the main oil screen. Spring over, check v. up
16. What would metal particles in the screen or sumps indicate? rings, pins, etc. pitting
17. What grade of oil is used in this engine? 1120 (60 SAE)
18. What would result if the time delay control valve stuck in the open position? low press
    Closed position? high pressure
19. Do all types of "Y" drain valves require safetying? varies
20. Are the sump plugs made of a magnetic material? Early, yes, later no.

Airplane & Engine Mech Course (Special B-24)
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PRE-OILING OF AIRCRAFT ENGINES
(Taken from T.O. 02-1-22)

A. Service activities will pre-oil engines, before operation, at times specified below:

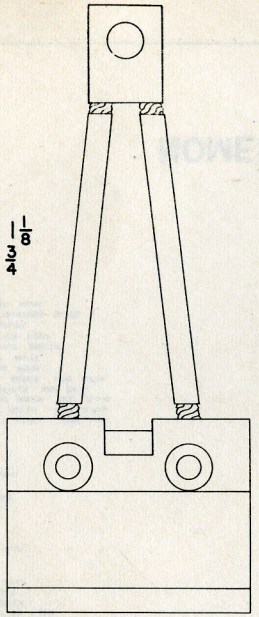
1. After engine change.
2. After each oil change.
3. After engine has been idle seven days or more.

B. Procedure:

1. Make sure that the oil level in the tank is high enough to furnish oil to the pump.
2. Remove the front spark plug from each cylinder and spray a quantity of oil into the cylinders above the horizontal line. The plugs should be left out to facilitate later turning of the engine.
3. Place one-half ($\frac{1}{2}$) pint of oil in the exhaust rocker box of each cylinder which has no inter-cylinder rocker box connection. The remaining rocker boxes will be lubricated by placing a sufficient quantity of oil in the first rocker box on each side of the engine above the horizontal center line. This quantity should total approximately one-half ($\frac{1}{2}$) pint per cylinder. This is accomplished by the following procedure:

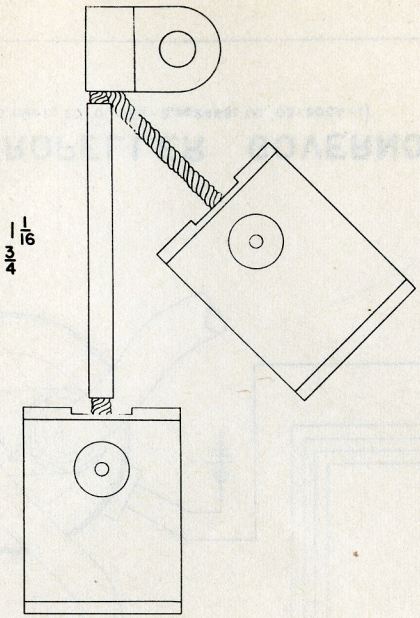
   a. Remove the following rocker box covers:
      1. Exhaust of cylinders #1,2,3,4, and 14. Intake.
      2. Intake of cylinder #12 and 13.
   b. Place engine oil, grade 1120, in the rocker boxes of the designated cylinders.
      1. $\frac{1}{2}$ pint in the exhaust of #1, 2, and 14. Intake
      2. 1 pint in intake of #12.
      3. $1\frac{1}{2}$ pints in exhaust of #3 and 4; also in intake of #13.
4. Replace rocker box covers. Torque 70 to 85 inch pounds.
5. Make sure ignition is "grounded out."
6. Place mixture control in <u>Idle Cut-Off</u>.
7. On an installation, it is necessary to remove the plug from the propeller dome and pour in enough oil to bring the oil to the level of the plug hole.
8. Remove the compensating oil pressure relief valve and turn the engine through until a steady flow of oil is discharged at the connection. This assures a flow of oil to the pump. If oil fails to reach the relief valve connection, check to see that oil reaches the pump. This may be done by disconnecting the oil inlet line to bleed out air trapped in the line.
9. Replace the compensating oil pressure relief valve. Check the condition of the crush gasket. A new gasket should be used every time the relief valve is removed and replaced.
10. Turn the propeller shaft through at least thirty (30) revolutions.
11. Replace the spark plugs. Torque 300 to 360 inch pounds.

① 8 BRUSHES
NEW LENGTH $1\frac{1}{8}$
REPLACE AT $\frac{3}{4}$

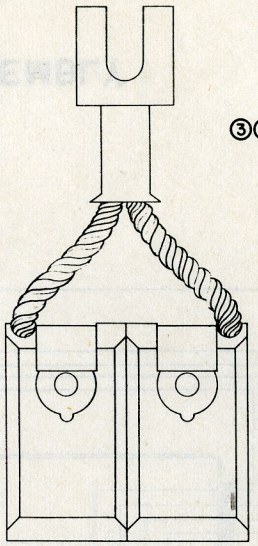


① WESTINGHOUSE

② 6pr. BRUSHES
NEW LENGTH $1\frac{1}{16}$
REPLACE AT $\frac{3}{4}$



② DELCO REMY

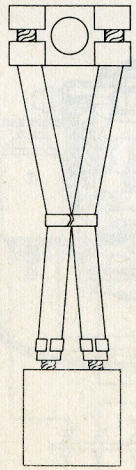


③④ 6pr. BRUSHES
NEW LENGTH $1\frac{1}{8}$
REPLACE AT $\frac{3}{4}$

③ FORD
④ GENERAL ELECTRIC

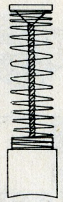
(GENERATOR BRUSHES)

⑤ 4 BRUSHES
NEW LENGTH $\frac{1}{2}$
REPLACE AT $\frac{5}{16}$

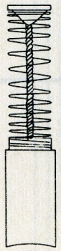


⑤ STARTER
⑥ FAST FEATHERING

⑥ 4 BRUSHES
NEW LENGTH $\frac{1}{2}$
REPLACE AT $\frac{11}{32}$



⑦ INTERCOOLER SHUTTER
2 BRUSHES
NEW LENGTH $\frac{1}{4}$
REPLACE AT $\frac{1}{8}$

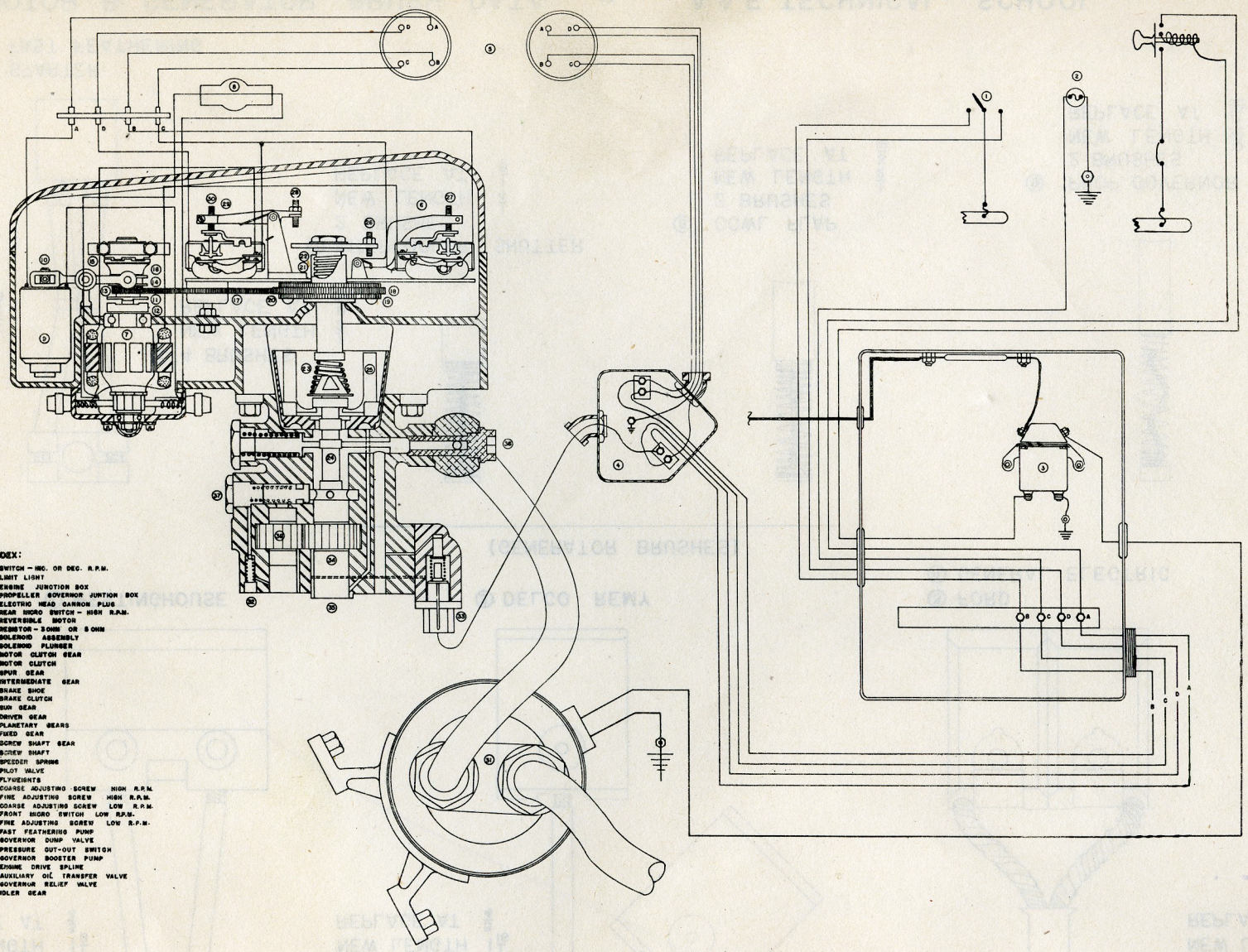


⑧ COWL FLAP
2 BRUSHES
NEW LENGTH $\frac{1}{2}$
REPLACE AT $\frac{3}{16}$

⑨ PROP. GOVERNOR
2 BRUSHES
NEW LENGTH $\frac{19}{32}$
REPLACE AT $\frac{11}{32}$

MOTOR & GENERATOR BRUSH DATA - A.A.F. TECHNICAL SCHOOL

J. PALLADINO 8-16-44



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1. SWITCH — HIG. OR DEG. R.P.M.
2. LIMIT LIGHT
3. ENGINE JUNCTION BOX
4. PROPELLER GOVERNOR JUNTION BOX
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7. REVERSIBLE MOTOR
8. RESISTOR - 3 OHM OR 5 OHM
9. SOLENOID ASSEMBLY
10. SOLENOID PLUNGER
11. MOTOR CLUTCH GEAR
12. MOTOR CLUTCH
13. SPUR GEAR
14. INTERMEDIATE GEAR
15. BRAKE SHOE
16. BRAKE CLUTCH
17. SUN GEAR
18. DRIVEN GEAR
19. PLANETARY GEARS
20. FIXED GEAR
21. SCREW SHAFT GEAR
22. SCREW SHAFT
23. SPEEDER SPRING
24. PILOT VALVE
25. FLYWEIGHTS
26. COARSE ADJUSTING SCREW HIGH R.P.M.
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30. FINE ADJUSTING SCREW LOW R.P.M.
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32. GOVERNOR DUMP VALVE
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34. GOVERNOR BOOSTER PUMP
35. ENGINE DRIVE SPLINE
36. AUXILIARY OIL TRANSFER VALVE
37. GOVERNOR RELIEF VALVE
38. IDLER GEAR

NOMENCLATURE - PROPELLER GOVERNOR ASSEMBLY

(T.O. 03-1-6, chpt. 11; T.O. 01-5EC-2, pg. 246B; T.O. 03-20CA-1)

ALLMAND 6-6-44

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

ELECTRICAL SYSTEM

A. Location and Function: (Parts followed by * to be located after removal of accessory.)

1. Generator.
   a. Air blast cover and blast tube.
   b. Mounting flange.
   c. Terminal box.
   d. Brush rigging assembly.*
   e. Field assembly frame.
   f. Cable generator to wing.
2. Starter.
   a. Starter jaw, baffle plate, oil seal.*
   b. Mounting flange
   c. Reduction gear housing.
   d. Motor and flywheel housing.
   e. Meshing solenoid and poppet.
   f. Meshing bell crank.
   g. Hand crankshaft extension and support bearing.
   h. Brush assembly spring release button.
      1. "OFF " and "ON" positions.
   i. Meshing cable.
   j. Hand meshing rod and bell crank.
3. Electric wire or cable from Engine Junction Box to:
   a. Engine instruments cannon plug in wing.
   b. Electric cable connection in Wing. (Hot line for starter, etc.
   c. Fast feathering pump motor.
   d. Intercooler shutter motor.
   e. Cowl flap motor.
   f. Energizing solenoid to starter.
   g. Starter meshing solenoid.
   h. Induction vibrator or Booster coil.
   i. Primer solenoid.
   j. Oil dilution solenoid
   k. Autosyn panel units.
   l. Oil temperature bulb.
   m. Heater solenoid
   n. Propeller governor.
4. Thermocouple cable.
5. Four (4) bonding connectors engine to mount.
6. One (1) bonding connector, autosyn panel.
7. Fast feathering solenoid.
8. Starter energizing solenoid.
9. Current limiter and spare, (slow-blow fuse).
10. Propeller cut-out switch.
11. Carburetor air thermometer connection.
12. Cowl flap motor and brushes.
13. Cowl flap control box, limit switches, and cams.

Job Sheet IV-5a

ENGINE SYSTEMS

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

ELECTRICAL SYSTEM

Col.No. Form 41B Interval	Inspection Required	Symbol	Remarks:
PF	1. Verify that all ignition switches are off.		
S	2. Removal of generator. (Do not remove Oil compensating relief valve).		
S	3. Removal of starter.		
	a. Disconnect external electrical connections.		
	b. Disconnect meshing cable at bell crank. Attached to engine mount.		
	c. Loosen, but do not remove, one of the upper nuts on the starter flange.		
	d. Remove the other 5 nuts on the flange and then remove the top nut.		
	e. Carefully remove starter from right side of engine.		
25	4. Make following inspections on generator		
	a. Check housing and mounting flange for cracks and other visible defects.		
	b. Using a wire hook, remove one set of brushes. Check for condition and proper length. New length is 1-1/16", min. length 3/4". T.O. 03-5AE-1. Record inspection, length, 1 1/16.		
	c. Check the tension of brush springs, which should be 20-26 oz. per brush.(03-5AE-1.)		
	d. Check for tightness of connections at brush terminals.		
	e. Check commutator for loose dirt, oil, wear glazed condition, roughness, out of round, and blackened edges. Commutator should have an even dark-brown color.		
	f. Check armature for play.		
	g. Replace brushes and check for binding.		
	h. Check brushes for seat. When necessary, reseating is done with No. 000 sandpaper. Starter brushes should be seated at least 50%.		
	i. Check connector assembly and terminal box for cracks and other failures.		
S	5. Make the following inspections on the starter. T.O. 03-1-6, Ch. 43, Parts A and B		
	a. Check the starter dog for meshing and retraction by pulling meshing cable.		
	b. Check clearance between bell crank and solenoid poppet. A max. of 1/32" or .031" is recommended. Adjust if necessary.		
50	c. Remove one brush and check for length and condition. Max. wear of brushes is 3/16" from new length of ½". Record inspection length, 7/16. When reseating is necessary use No. 000 sandpaper between brush and commutator with sanded side next to brush and pull in direction of rotation.		
	d. Inspect brush leads for proper convering and attachment.		

ELECTRICAL SYSTEM

Col. No. Form 41B Interval	Inspection Required	Symbols	Remarks:
50	e. Check brush spring tension, making sure brush spring release is "ON" position. Raise spring 1/8" above brush box. Spring tension should be 24-28 oz. per brush. If necessary to adjust spring tension, remove cotter pin and rotate adjusting sleeve clockwise to increase, and counterclockwise to decrease spring tension.		
50	f. Check commutator; if dirty or rough, smooth and polish with No. 000 sandpaper. Check armature for play. None allowed.		
50	g. Replace brush and check for free fit in holder, without excessive side play or binding.		
S	h. Inspect lowest point of flywheel housing for presence of 3/16" diameter oil drain hole. If not present, remove fly wheel housing and drill 3/16" diameter drain hole. Make certain no chips remain in flywheel housing when reassembling.		
D	i. Inspect entire starter for: 1. Cracked housing and flange. 2. Tightness of bolts and nuts. 3. Proper safetying. 4. Evidence of oil leaking at parting surface of housing sections.		
	6. Install starter and hand meshing rod. Make necessary electrical connections and then perform the following:		
S	a. Check hand meshing cable for proper play. There must be 1" free movement at right angles to cable when hand meshing rod is in clip flange on top of clip. Adjust by lengthening the rod or moving meshing rod bell crank on engine mount.		
	b. Check to see that you cannot insert a wire through the inspection hole in meshing bell-crank clevis on engine mount.		
	c. Check starter for security of mounting and security of electrical connections.		
D	7. Replace generator and perform the following: a. Check for security of mounting. b. Check cable for looseness, chafing, and safety. Read T.O. 01-1-48. Instructor initial.		
	8. Replace hand crank extension. a. Inspect hand crank extension brackets and supports for security of mounting and general condition.		
50	b. Lubricate hand crank extension support bearings with engine oil.		

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

ELECTRICAL SYSTEM

ColNo. Form 41B Interval	Inspection Required	Symbol	Remarks:
	c. Energize starter for about 10 seconds and mesh with meshing switch.		
	d. Check to see if starter dog has retracted. If not, rock the propeller back and forth until the dog has retracted.		
50	9. Inspect all the following electric lines for tightness and condition of connections; breaks; scuffed, burnt, or frayed insulation; and tightness of all cannon plugs, 1/8 to 1/4 turn beyond finger tight; from Engine Junction Box to:		
	a. Engine instruments cannon plug in wing.		
	b. Electric cable connection in wing. Power line for starter, and fast feathering pump.		
	c. Fast feathering pump motor.		
	d. Intercooler shutter motor.		
	e. Cowl flap motor.		
	f. Energizing solenoid to starter.		
	g. Starter meshing solenoid.		
	h. Induction vibrator or Booster coil.		
	i. Primer solenoid.		
	j. Oil dilution solenoid.		
	k. Autosyn panel units.		
	l. Oil temperature bulb.		
	m. Heater solenoid.		
	n. Propeller Governor.		
	10. Check the following for operation:		
PF	a. Fast feathering pump.		
PF	b. Intercooler shutter motor, open and closed positions.		
PF	c. Cowl flap motor, operation of flaps up and down.		
PF	d. Primer solenoid.		
PF	e. Induction Vibrator or Booster coil.		
50	f. Oil dilution solenoid.		
50	g. Heater solenoid.		
PF	h. Propeller governor. Check both increase and decrease rpm lights. Observe limit lights approximately 12-19 seconds. Instructor will explain theory of electric head and adjustment of limit switches during laboratory.		
	11. Inspect bonding--engine to mount, and at autosyn panel--for:		
	a. Breaks, tears, and kinks.		
	b. Contact or rubbing with other parts.		
	c. Security of bonding connections.		
	12. Cowl flap motor. T.O. 03-5CE-2. Inspect for the following:		
100	a. Mounting bolts and elastic stop nuts for tightness.		
100	b. Tightness of ring nut holding connector plug in place		
100	c. Cracks or breaks in the casting.		

ELECTRICAL SYSTEM

Col.No. Form 41B	Interval	Inspection Required	Symbol	Remarks:
	100	d. Tightness of safety wires, screws, and nuts. Note: Brushes and commutator of the motor are to be inspected every 500 flying hours. Brushes are to be replaced if necessary. The maximum permissible brush wear is reached when brushes have worn to a length of 3/16" on the long side. When removing brushes note the position of the brush and replace it in the same position at installation. If necessary to clean the commutator, use No. 000 sandpaper. Remove particles of metal with a dry air stream.		
	S	e. Set the position of the cowl flaps as directed by the instructor.		
	100	13. Intercooler shutter motor. T.O. 03-5CE-1. Inspect for the following:		
		a. Mounting bolts, nuts, and cotter pins for condition and security.		
		b. Ring nut holding connector plug to see it is in place and tight.		
		c. Casting for cracks or breaks.		
		d. Safety wire, screws, and nuts for tightness. Note: Brushes and commutator of the motor are to be inspected every 500 flying hours. Brushes are to be replaced if necessary. The maximum permissible brush wear is reached when brushes have worn to a length of 3/16" on the long side. When removing brushes, note the position of the brush and replace it in the same position at installation. If necessary to clean the commutator, use No. 000 sandpaper. Remove particles of metal with dry air stream.		
		14. Fast feathering pump. T.O. 03-30CA-2.		
		a. Check for security of mounting. Tighten all loose connections.		
	50	b. Check brushes for free fit in boxes without excessive side play. Binding brushes and boxes should be cleaned with undoped gasoline saturated cloth. Max. Brush wear is 5/32" from new length of 1/2".		
		c. Seat new brushes with No. 000 sandpaper. Note: The generator will be removed and checked for freedom of rotating parts at the 100 hr. inspection. Pumps will be removed for overhaul at engine change or as specified in T.O. 03-1-4.		
	50	15. Inspect the following for security of attachment, condition, and evidences of corrosion.		
		a. Primer solenoid		
		b. Oil dilution solenoid.		
		c. Starter relay solenoid.		
		d. Fast feathering solenoid.		
		e. Heater solenoid.		
		f. Oil temperature bulb.		

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

QUESTIONS:

1. What damage will oil on the generator armature do?
2. What is the voltage rating of the generators? 28.5
3. How many brushes are used in the Ford Generator? 2 General Electric? 2 Westinghouse? 8
4. What is the minimum and new length of generator brushes allowed? 1/8 3/4
5. How are generator brushes seated?
6. Why do brushes tend to flake at high altitudes and not at low altitudes?
7. What is the gear reduction of the starter?
8. What is the rated speed of the motor? The dog?
9. Where is a 3/16" hole drilled in the starter and why? bottom, drain
10. What is the purpose of the clutch?
11. What type clutch is used?
12. Trace electrical circuit from battery to starter.
13. Suppose the starter started smoking when energized, what might the trouble be?
14. How many brushes are used in the Eclipse starter?
15. Where is the meshing solenoid located?
16. What is the outcome of the seal in the starter leaking?
17. What is the torque on the starter clutch?
18. What is the minimum and maximum length of starter brushes allowed?
19. What is the purpose of the button on the rear of the starter?
20. If clearance between meshing solenoid and arm is too little, what is the result?
21. What is the clearance between the meshing arm and solenoid?
22. Why should precaution be taken to insure proper length of the hand meshing cable? long - ht cowling / short - inflight meshing
23. What is the difference between G-6 and F-2 starters and why are G-6 starters better?
24. How can the oil dilution solenoid, if leaking be remedied? damaged insulation
25. How may the cowl flap motor brushes be replaced incorrectly?
26. How is it permissible to shorten a thermocouple wire to make it fit into a nacelle? wrap & tape

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

VACUUM SYSTEM

A. Location and Function:

1. Line from wing to backfire check valve.
2. Backfire check valve.
3. Suction relief valve.
4. Suction line to "IN" side of pump.
5. Vacuum pump.
6. Pressure line from "OUT" side of pump to oil separator.
7. Oil Separator.
8. Oil return line from separator to accessory section.
9. Line from separator to safety (pressure relief) valve.
10. Pressure relief valve.
11. Pressure Check Valve.
12. Pressure line in wing leading to fuselage.

B. Questions and Related Information:

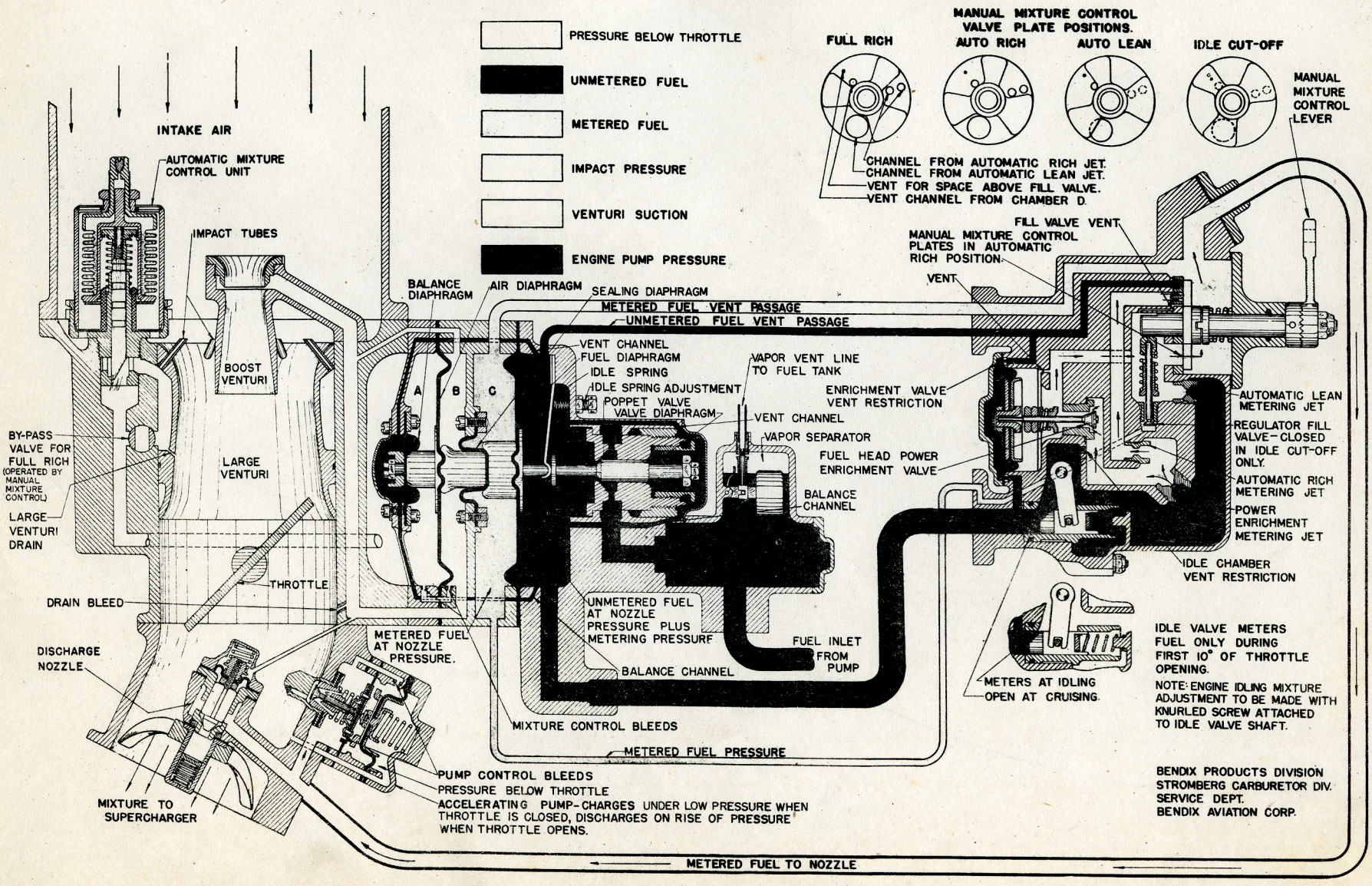
1. At preflight, suction gage should read 4½ inches Hg.
2. The safety (pressure relief valve) opens at about 24 inches Hg. and then maintains a pressure of from 15 inches to 19 inches Hg.
3. The suction relief valve is mounted with the screen facing downward or to one side but never upward.
4. To check for correct lubrication of the vacuum pump, run the engine at 1000 r.p.m. for 10 minutes; the oil discharge at the oil separator oil outlet should be at least 4 cubic centimeters, or at least 4 drops per minute.
5. Could this pump be lubricated from an external source on the engine if necessary? Where is this external source?
6. In which direction would you turn the adjusting screw on the suction relief valve to increase the amount of suction? To decrease the amount of suction?
7. Does the pressure from vacuum pumps 1 and 2 enter the fuselage in one or two tubes? Look in region of wing firewall, #2 engine.
8. Does the vacuum from pumps 1 and 2 enter the fuselage in one or two pipes?
9. How does oil normally flow from the top to the bottom bearing?
10. What precaution regarding the gasket is taken when installing a pump?
11. In what position is the separator mounted? Why?
12. Would pressure relief valve, stuck in the open position, interfer with the vacuum developed?

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

VACUUM SYSTEM

Col.No. Form 41B Interval	Inspections Required	Symbols	Remarks
D	1. Inspect the following lines for proper identification, mounting, loose or broken tubing, tightness of hose clamps. (03-1-20,-29), and chafing.		
	a. Wing to backfire check valve		
	b. Backfire check valve to suction relief valve.		
	c. Suction relief valve to pump		
	d. Pump to oil separator.		
	e. Oil separator to accessory section.		
	f. Oil separator to pressure safety valve.		
	g. Pressure safety valve to check valve.		
100	2. Inspect vacuum pump for:		
	a. Security of mounting and proper safetying. (03-30AA-1)		
	b. Evidence of oil leaks and condition of gasket at mounting flange.		
100	3. Inspect the backfire check valve for proper installation and security.		
100	4. Inspect the suction relief valve for security of mounting and general condition.		
100	5. Inspect the suction relief valve screen and, if dirty, remove the valve and loosen the screen. The screen is cleaned in gasoline and then replaced. (03-30AA-1).		
100	6. Inspect oil separator for security and condition of rubber mounting, and proper installation.		
100	7. Remove and clean oil outlet fitting and screen of oil separator. Replace. (03-30AA-1).		
100	8. Inspect safety (pressure relief) valve for security and proper attachment.		
100	9. Remove the valve guide from the safety valve and wash in a suitable cleaning fluid. If the valve disc is worn, dress it carefully with a flat oilstone, (03-30AA-1).		
100	10. Check the pressure check valve for proper attachment and general condition.		

SCHEMATIC DIAGRAM OF STROMBERG INJECTION CARBURETOR WITH FUEL HEAD ENRICHMENT VALVE.



CARBURETOR MODELS PD12F2, PD12F3, PD12H1

PRINTED IN U.S.A.

SCHEMATIC DIAGRAM OF STROMBERG INJECTION CARBURETOR

WITH LOW HEAD ENRICHMENT VALVE

Job Sheet
IV-7

ENGINE
SYSTEMS

Airplane & Engine Mech Course Special B-24)
FORD AIRPLANE SCHOOL

FUEL SYSTEM

INSPECTION AND WORK SHEET

Locate each unit listed below and be able to state its function:

1. Nacelle fuel inlet line.
2. C-4 Strainer.
   a. Inlet
   b. Outlet
   c. Drain Cock
   d. Strongback.
3. Fuel pump
   a. Inlet Port
   b. Drain Line.
   c. Lubricating Port(s)
   d. Pressure Adjustment.
   e. Regulator Section.
   f. Vent Line.
   g. Outlet Port.
   h. Instruction Plate.
4. Gang Drain.
5. Internal Supercharger
   a. Drain Line.
   b. Drain Valve.
6. Carburetor.
   a. Inlet Line.
   b. Two vapor eliminator chambers.
   c. Vent Line.
   d. Fuel Screen Cover.
   e. Metered fuel line to discharge nozzle.
   f. Drain Plugs in Chambers C, D, and B.
   g. Adapter Section.
   h. Idle speed Adjustment Screw.
   i. Idle Mixture adjustment Screw.
   j. Throttle Control.
   k. Mixture Control.
   l. Idle Cut-Off Position.
   m. 65% safety Throttle
   n. Primer Take-Off.
   o. Pressure Take-Off.
   p. Throttle Section.
   q. Fuel Control Section.
   r. Regulator Section.
7. Primer
   a. Solenoid.
   b. Main Line.
   c. Spider Distributor.
   d. Lines to Cylinder.
   e. Lowest Cylinder Primed.
8. Oil Dilution System:
   a. Fuel Inlet Line to Solenoid from Carburetor.
   b. Solenoid.
   c. "Y" or "T" Junction in Line at Oil Dilution Solenoid.
   d. Line to "Y" Drain
   e. Solenoid Drain Plug.
9. Fuel Pressure Autosyn.
   a. Fuel Inlet Line
   b. Vent Line.
10. Heater Lines.
   a. Fuel-air Mixture Take-Off.
   b. Solenoid.
   c. Exhaust Fitting.

ENGINE SYSTEMS

Job Sheet IV-7a

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

FUEL SYSTEM INSPECTION AND WORK SHEET

Col.No. Form 41B Interval	Inspections Required	Symbols	Remarks:
D	1. Check main fuel line into nacelle to C-4 strainer for chafing and clamps for tightness. All hose clamps are checked for tightness daily until hose ceases to "cold-flow" and the hose clamps remain tight; and then hose clamps are inspected at the 50 hour period (T.O. 03-1-29: 03-1-20).		
25	2. Inspect all fuel lines for the following: a. Insecurity of Line Anchorage. b. Wear due to vibration or chafing. c. Condition of hose connection. d. Tightness of hose connection. e. Chafing or cutting into lines by clamps, screws, bolts, etc. (T.O. 01-5EC-2 p.86.)		
PF	3. Drain sufficient fuel from the C-4 strainer to insure the removal of any water in the fuel system (note that this strainer is the lowest point in the fuel system, hence any water would collect here). Close drain cock (normally it would also be necessary to safety drain cock to wing nut at this time).		
25	4. Remove and clean the screen in the C-4 strainer. Inspect screen for breaks and tears. Check for evidence of self-sealing tank or line failure indicated by rubber particles. Clean strainer body. Replace strainer, be sure right side of strainer is up and recessed at top of the body. Safety cover properly with braid of wire diagonally across the strong-back from one hinge pin to the other, and wing nut to drain cock. Instructor's Check _____.		
D	5. Check fuel pump for security of mounting and proper safetying. Check hose to pump for tightness and for chafing.		
100	6. Lubricate Pesco fuel pump by filling seal chamber half full with cup grease Spec-VV-G681 (this is also done when new pump is installed). Apply a Zerk or Alemite fitting in one of the pipe tapped connections next to the mounting pad (T.O. 01-5EC-2 p. 86).		
D	7. Check fuel line from pump to carburetor for security of clamps and for tightness. Check all safety wiring on carburetor and see that it is installed where necessary.		
25	8. Remove and clean carburetor fuel screen. Use air blast to clean screen. Replace screen properly by putting, flanged end in first, the tension spring in the cup end of the strainer. Install cover, and safety bolt to eye on carburetor. Instructor's Check _____.		
50	9. Drain carburetor by removing plugs in the bottom of the regulator unit, air chamber, fuel chamber, and fuel control unit (T.O. 03-10BA-2). The		

Col. No. Form 41B Interval		Inspection Required	Symbol	Remarks
		purpose of this is to remove any accumulation of moisture in the air chambers, and any sediment in the other compartments. Replace plugs and safety them properly with .020 wire. Instructor's Check _____.		
50	10.	Lubricate throttle shaft bushings, if available use machine oil Spec. "2-27. (Note: The mixture control latch mechanism is NOT greased on this type of carburetor, see T.O. 03-10BA-2 Sec. IV).		
50	11.	Nacelle heater system - check fuel air and exhaust gas tubing lines and fitting from take-off to rear firewall connection, for security of mounting and tightness of clamps and connections (T.O.01-5EC-2 p. 102).		
25	12.	Since you have already removed and replaced the carburetor fuel screen, now complete the rest of that inspection: while carburetor strainer is filled with air, disconnect flexible hose at the vent line and observe the action of the vapor eliminator. It should be possible to notice the rush of air being expelled and then cease when the fuel level raises the float and shuts off the vent passage. On this type of carburetor a seepage of 40 to 60 cc. per minute is normal (T.O. 03-10BA-2 Sec. IV., 1).		
50	13.	Refill carburetor - the following procedure is carried out whenever the carburetor has been drained, the carburetor has been replaced or a new carburetor installed: a. Set mixture control to automatic rich. b. Move throttle to halfway open position. c. Turn on booster pump. d. Continue to supply fuel until a small amount flows from the supercharger drain valve through the gang drain.		
D	14	With carburetor in IDLE CUTOFF and fuel pressure built up by the booster pump inspect the following for leakage: a. Line to C-4 Strainer b. Line to fuel pump. c. Line to carburetor. d. Carburetor Drain Plugs, parting surface of body casting. e. Primer Lines. f. Oil dilution line. g. Fuel pressure Autosyn Line.		
D	15.	With carburetor in IDLE CUTOFF and fuel pressure built up by booster pump, remove flexible line at primer solenoid and check solenoid when in the OFF position for leakage. No leakage at all is permitted. (A leaking primer would cause engine to gallop, smoke, and fail to idle; a serious leak would be indicated by a loss of 2 or 3 lbs. Fuel pressure.)		

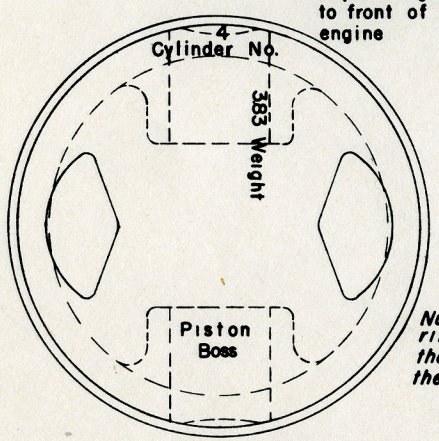
Col.No. Form 41B	Interval	Inspection Required	Symbols	Remarks:
	25	16. With carburetor in IDLE CUTOFF and fuel pressure built up by booster pump, check fuel pump for leakage. Also remove drain line to gang drain and check for leakage. Any drive shaft seal leakage in excess of 10 drops per minute is cause for rejection (T.O. 03-5EA-1 Sec. V.). If necessary, adjust pressure to deliver 16 to 18 p.s.i. for both Stromberg and Ceco carburetors. Resafety adjusting screw.		
	25	17. With carburetor in IDLE CUTOFF and fuel pressure built up, inspect oil dilution solenoid for leakage by removing plug at the bottom. Maximum allowable leakage is 10 drops per minute. If leakage exceeds this, reinstall plug, turn oil dilution switch "on" and "off" for ten 5 second periods while pressure is built up. Remove plug and again check for leakage, if still excessive push end of plunger up and down several times with a steel rod or finger to produce better seating of the valve. Recheck, and if leakage is still excessive, the solenoid is replaced (T.O. 03-15-3).		

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

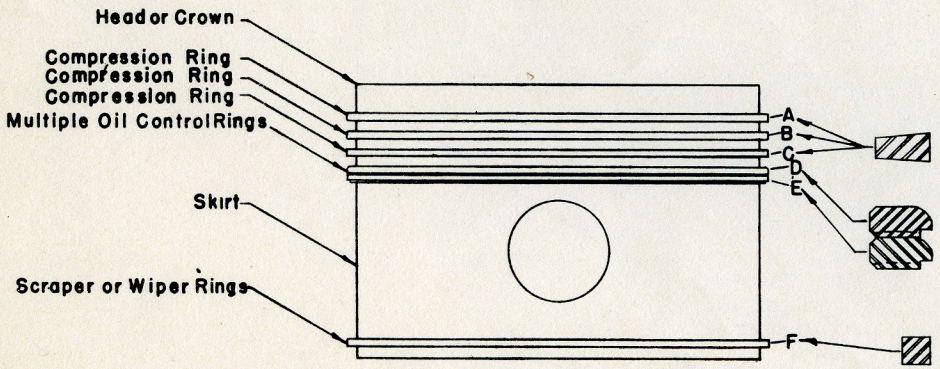
The instructor may ask you the following questions:

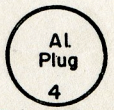
1. If rubber particles are found when draining and/or cleaning the C-4 strainer, what trouble would you look for? Fuel cell deterioration
2. Does draining the C-4 strainer drain any part of the carburetor? No
3. How is the fuel pump safetied to the engine? Lockwasher nut? To what are the regulator housing screws and the adjustment screw safetied? wire
4. What type and make (s) of fuel pump are used on the B-24? G-9 Pesco, or Thompson
5. When installing a new pump, why must precaution be taken to insure that the regulator housing is properly installed?
6. What is the purpose of the flexible line from the fuel pump to the carburetor air scoop? (T.O. 03-10EA-1 Sec. IV, 2). Supp air + fuel
7. How and where is adjustment for fuel pressure made? Fuel Pump
8. How and where is adjustment made for idling speed? Mixture screw For idling mixture? knurled nut
9. Where does the internal supercharger drain go overboard? Magneto drive How does the internal supercharger drain valve work?
10. Where does the fuel passed by the vapor eliminator return? Tank
11. Where does the fuel for oil dilution come from? Carburetor Specifically from what part or section? Screen chamber
12. Where is the other place that a primer solenoid may be located in B-24 nacelles?
13. What relation, if any, is there between an oil dilution solenoid stuck in "open" position and engine breathers throwing oil? (T.O. 02-1-29, 19E.)
14. What is the purpose of the vent line to the fuel pressure autosyn?
15. From where does the fuel leaking from the gang drain come the moment the engine is stopped? internal impeller drain
16. What is the purpose of the 65% safety throttle? Safe throttle pin = linkage failure
17. Describe the flow of fuel from C-4 Strainer to intake ports during priming.
18. Whence do the fuselage heaters get their fuel? Why is, or is not, the heater exhaust vented overboard?
19. What are the identification markings for self-sealing aromatic resistant hose, non-self-sealing aromatic resistant hose, non-self-sealing and non-aromatic resistant hose? (T.O. 04-5-12).
20. Why isn't #5 cylinder primed? intake below horiz line
21. How many lines take fuel from the carburetor? What are they?
22. What seal, if any, is used between the carburetor and the engine? (T.O. 01-5EC-2 p. 216). Oil seal
23. Why aren't hose clamps on self-sealing hose safetied?
24. What torque is applied to hose clamps? (T.O. 03-1-29) Just tight + 1½
25. How long should a new carburetor diaphragm soak before it will be efficient? 8 hrs (T.O. 01-5EC-2 p. 212) acc to temp, 2-9 min
26. What is the procedure for diluting oil? (T.O. 01-5EC-2 p. 50; 02-1-29 Sec. IV,17)
27. What procedure would you follow to prepare a carburetor for storage? (T.O. 01-5EC-2 pp. 211-2).
28. What torque is applied to the mounting screws when installing the carburetor? 17-20 ft# 300-350 (T.O. 01-5EC-2 p. 217).

RING CLEARANCES



Numbers on all rings go towards the bottom of the piston





This end goes to front of engine

Side Clearance - Piston - Piston Ring

	Min.	Max.
(A) 1st Groove	.003	.005
(B) 2nd Groove	.003	.005
(C) 3rd Groove	.003	.005
(D) 4th Groove	.004	.007
(E) 4th Groove	.004	.007
(F) 5th Groove	.003	.005

END CLEARANCE - PISTON RING

(A) 1st Groove	.0595	.0665
(B) 2nd Groove	.0595	.0665
(C) 3rd Groove	.0595	.0665
(D) 4th Groove	.0565	.0635
(E) 4th Groove	.0565	.0635
(F) 5th Groove	.0135	.0205

(50% over maximum allowed before replacement)
5th Groove - With Chrome Moly. Barrels uses compression ring in place of scraper ring.

Clearance Between Barrel and Piston .021 - .025

Engines equipped with Nitralloy (#139) or CHROMIUM Plated Barrels (# Yellow & Red band & etched Chrome Plated use following numbered rings in grooves
(A) - 31406, (B) - 31406, (C) - 31406, (D) - 19667, (E) - 19667, (F) - 39711 or 17004

Engines equipped with Chrome Moly Barrels (#185)
(A) - 50512, (B) - 31406, (C) - 31406, (D) - 19667, (E) - 19667, (F) - 39711 or 17004
(When 17004 is used in "F" 39711 must be used in #1, #2, #8 cylinders others can use 17004.

Wedge Type Compression Ring, must be used in wedge type groove.

Oil Control Ring, must be placed with flutes down.

Plain square type compression ring.

Oil Scraper ring similar to "D" or "E" can be used in this groove in certain barrels as given above.

RING CLEARANCES

Side Clearance - Piston - Piston Ring

	Min.	Max.
(A) 1st Groove	.002	.003
(B) 2nd Groove	.002	.003
(C) 3rd Groove	.002	.003
(D) 4th Groove	.004	.007
(E) 4th Groove	.004	.007
(F) 5th Groove	.003	.005

END CLEARANCE - PISTON RING

(A) 1st Groove	.0595	.0665
(B) 2nd Groove	.0595	.0665
(C) 3rd Groove	.0595	.0665
(D) 4th Groove	.0565	.0633
(E) 4th Groove	.0565	.0633
(F) 5th Groove	.0135	.0205

(50% over maximum allowed when replacement)

5th Groove-With Chrome Moly Barrels use compression ring in place of scraper ring.

Clearance Between Barrel and Piston .021-.022

Engines equipped with Nitralloy (N135) or CHROMIUM Plated Barrels in Position 6, Rod Bend 6, pitched Chrome Plated non rattling nonbarred rings in grooves (A)-31406, (B)-31406, (C)-31406, (D)-19667, (E)-19667, (F)-35711 or 17004

Engines equipped with Chrome Moly Barrels (N165) (A)-30512, (B)-31406, (C)-31406, (D)-19667, (E)-19667, (F)-35711 or 17004

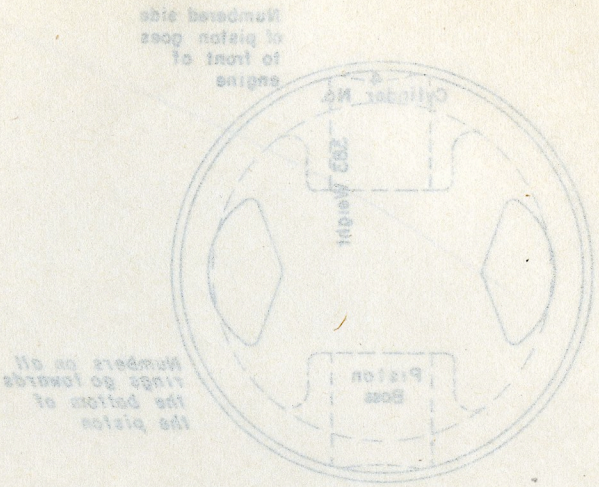
(When 17004 is used in "F" 35711 must be used in 1, 2, 3, 4 cylinders others can use 17004.

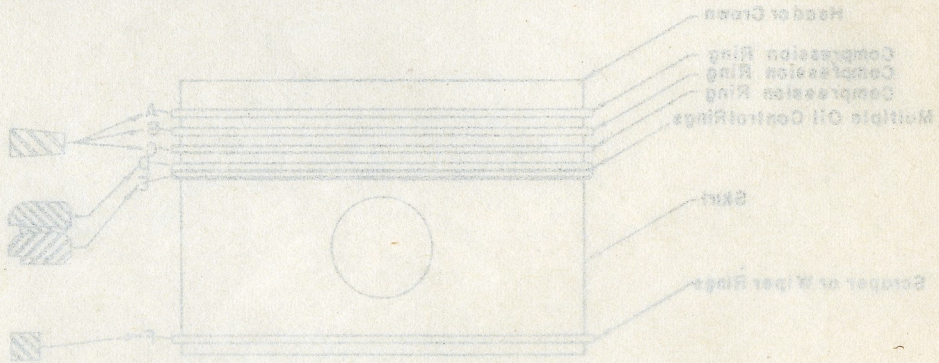
Wedge Type Compression Ring, must be used in wedge type groove.

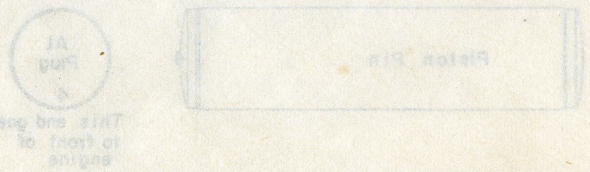
Oil Control Ring, must be placed with flutes down.

Plain square type compression ring

Oil Scraper ring similar to "D" or "E" can be used in this groove in certain barrels as given above.







Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

ENGINE REPAIR AND MAINTENANCE

A. Location:

1. Nose Section.
2. Power Section or crankcase (3 pieces).
3. Supercharger and mounting section.
4. Intermediate section.
5. Accessory section.
6. Cylinders 5 and 12.
7. Cylinder baffles.
8. Push rod housing packing nuts.
9. Flared end of push rod housing.
10. Numbered end of push rod.
11. Numbered end of piston and pin.
12. Piston.
    a. Head.
    b. Skirt.
    c. Boss.
    d. Lands.
    e. Ring grooves.
13. Weight of piston.
14. Compression, oil control and oil scraper rings.
15. Numbered side of piston rings.
16. Intake and exhaust valves.
17. Valve safety circlet.
18. Valve tip, stem, neck or fillet, face, margin, head.
19. Valve seats and guides.
20. Split cone valve keepers, intake and exhaust.
21. Cylinder head, barrel, and mounting flange.
22. Tappets, tappet guides, tappet housing.
23. Engine shock mount brackets.
24. Shock mounts.

B. Questions:

1. Why must rocker box covers be removed in pairs when interconnected?
2. When removing push rods why must piston be set at T.D.C. compression?
3. Can push rod and cover be installed incorrectly? How?
4. Why is there a hole in the push rods?
5. Why is it necessary to be positive of valve clearance when the push rods have been replaced.
6. Why is the exhaust valve larger and heavier than the intake?
7. How is the valve seat checked for seating?
8. What is the value of the safety circlet?
9. What type of locking device is used for cylinder hold down nuts?
10. What torque is used on spark plugs?
11. What torque is used on cylinder hold down nuts?
12. Are the push rods all of the same length and why?
13. Why must rings be placed with numbers towards the bottom of the piston?
14. What provision is made to keep the piston pin from scoring the cylinder wal
15. Are all cylinder barrels made of the same material, how can you tell? (T.O. 02-10-10 Par. 3
16. How do you check the valve face for seating?
17. How many valve springs are used per cylinder and why?
18. What torque is used on rocker box cover nuts?

B. Questions (Continued)

19. What size propeller shaft is used on the R-1830-43 engine?
20. What damage might result if the wrong rocker arms are depressed while adjusting valve clearances when using the positive method?
21. What disposition must be made of sodium filled valves? (T.O. 02-1-67)
22. What is the minimum clearance between the rocker arm and valve spring washer? If the clearance is less than the minimum, how is correction made? See T.O. 02-10CB-3, P. 93

Job Sheet
IV-8b.

ENGINE SYSTEMS

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

Col.No.
Form
41B

ENGINE REPAIR AND MAINTENANCE

Interval	Inspection Required	Symbols	Remarks:
D	1. ~~Inspect the engine mount~~ for general condition and security of attachment. Check for cracks particularly at the welds. Check mounting bolts for condition and safetying.		
D	2. Inspect engine shock mount brackets for evidence of deterioration, cracks, and proper safetying.		
D	3. Inspect the following engine sections for cracks and general condition:		
	a. Nose		
	b. Crankcase		
	c. Supercharger and mounting		
	d. Intermediate		
	e. Accessory		
D	4. Check for broken, damaged, or clogged cylinder baffles, also inspect cylinder for general condition and particularly for damaged or broken fins.		
25	5. Check intake pipe packing nuts for tightness at the first 25 hour inspection after engine overhaul: tighten if evidence of leakage is found. If leakage is still found during subsequent inspections, put in a new packing gland. (T.O. 02-1-28)		
50	6. Inspect for tightness of cylinder stud nuts on one cylinder, Remove, replace and properly torque 4 nuts. Torque in inch pounds: 300 minimum, and 350 maximum. (T.O. 02-10-1; p. 96.		
50	7. Check for leakage of oil at the propeller thrust bearing retaining nut.		
D	8. Inspect for tightness of engine date plate. If loose, refer to T.O. 02-10-39A for maintenance procedure.		
S	9. Remove the push rods from a cylinder designated by your instructor. 4 or 12		
	a. Remove the rocker box covers, in pairs if inter-connected. Handle gaskets carefully.		
	b. Remove front spark plug on subject cylinder.		
	c. Set piston at T.D.C. compression stroke.		
	d. Loosen push rod cover packing nuts.		
	e. Depress rocker arm with rocker arm depressor and remove push rods and covers. DO NOT DROP PUSH-RODS.		
	f. Inspection.		
	1. Check ball ends for excessive wear and cracks.		
	2. Check push rods for straightness.		
	3. See that oil passage is open.		
	4. Check push rod cover tube and packing for condition. (See T.O. 01-5EC-2 p.204, (2) (e), p.206. (4) (b).		

ENGINE REPAIR AND MAINTENANCE

Col.No. Form 41B	Interval	Inspection Required	Symbols	Remarks:
		g. Replacement		
		1. Lubricate ball ends of push rods.		
		2. Replace push rod by depressing rocker arm. Locate numbered end of rod and flared end of housing toward CRANKCASE and install. Make certain that the push rod is properly seated by lifting the housing and spinning the rod freely. Also double-check by checking the rocker arms for valve clearance.		
		3. Tighten and safety cover packing nuts, tappet end first.		
		4. Adjust valve clearances as directed on following sheets. See T.O. 02-10CB-3 p. 92, 01-5EC-2, p. 209		
		5. Replace rocker box cover. Torque nuts 70 to 85 in. lbs.		
		6. Replace and torque spark plug to 300 to 360 inch lbs.		
		7. Replace connector and elbow. Caution: Do not tighten excessively. See T.O. 01-5EC-2, p. 220)		
S		10. Valves, use spare cylinder on the bench.		
		a. Place cylinder on wooden block,(cylinder tree).		
		b. Compress valve springs using PWA valve spring compressor, remove the split cone keepers, upper washer, and valve springs, removing the inner spring first.		
		c. Remove safety circlet from the valve stems, and holding the valve stems lift the cylinder from the tree, remove the valves using care not to drop them.		
		d. Inspection. (T.O. 02-1-6, Gives Valve Inspections).		
		1. Check valve stem, fillet, face, margin, and head for signs of failure.		
		2. Check springs for breaks and other signs of weakness.		
		3. Inspect valve guides and seats for evidence of failures.		
		e. Replacement		
		1. Oil valve guides and insert valves.		
		2. Place cylinder on tree to hold valves in place.		
		3. Replace safety circlets in grooves on valve stems.		
		4. Insert valve springs and upper washer.		
		5. Compress valve springs, using PWA compressor and install keepers. Be sure all serrations and grooves inter-lock on exhaust valve keeper. Have instructor initial here approving installation.		

Job Sheet
IV-8d

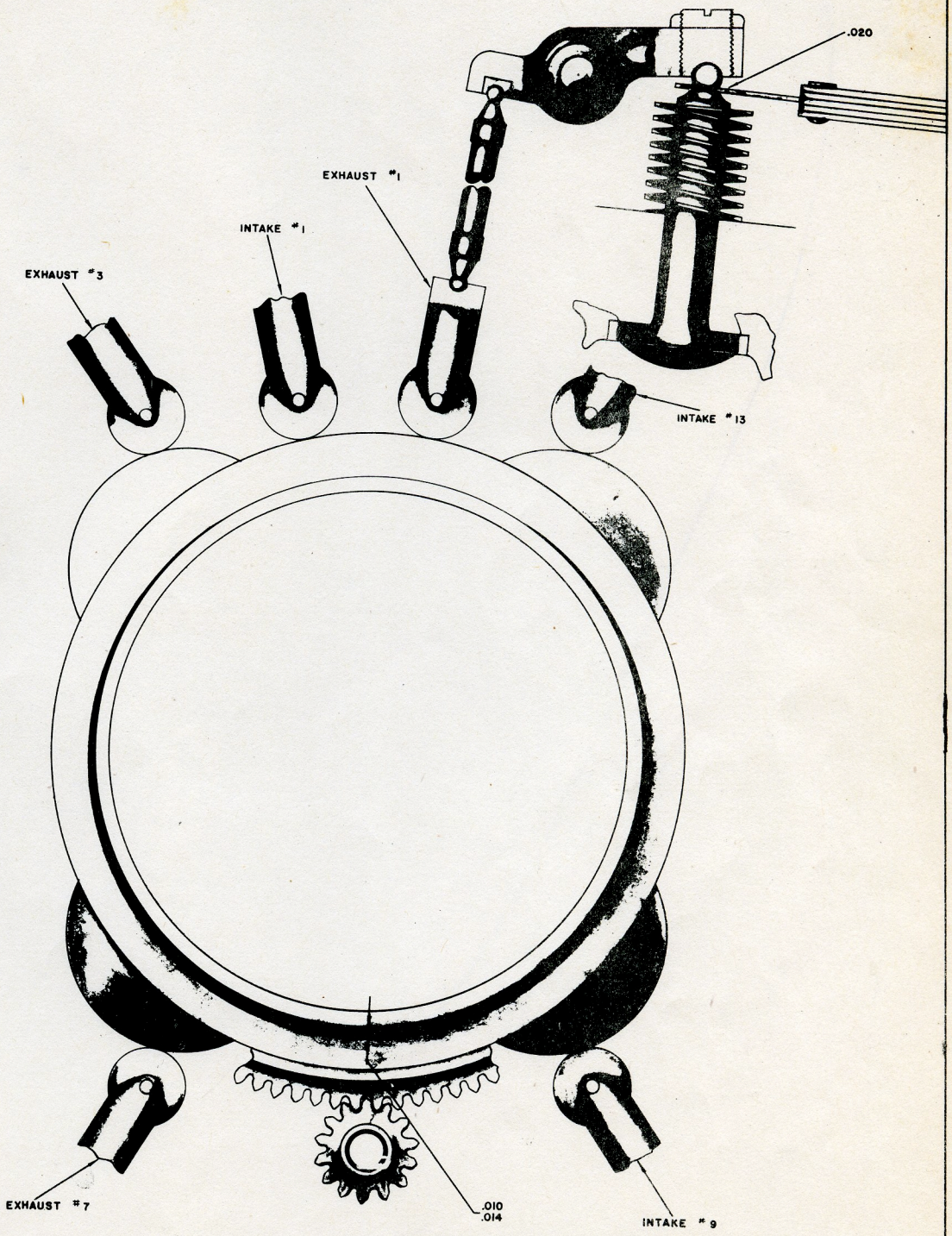
ENGINE SYSTEMS

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

ENGINE REPAIR AND MAINTENANCE

Col. No. Form 41B Interval	Inspection Required	Symbols	Remarks:
S	11. Piston and Piston Rings.		
	a. Inspect the general condition of the piston by looking for signs of excessive wear, cracks, distortion of ring lands, and scratches.		
	b. Check the piston for "dishing" by placing a straight edge across the top of the piston and measuring the clearance if any is found. The maximum allowable clearance is .008 inch. T.O. 02-10CB-3, p. 58.		
	c. Have instructor demonstrate removal and replacement of rings.		
	d. Inspect all rings for general condition.		
	e. Measure the side clearance of each ring and list measurements T.O. 02-10CB-3, p. 59 Groove 1.____ 2.____ 3.____ 4.____ 5.____		
	f. Measure the end clearance of each ring and list measurements. Use piston ring gage. Groove 1.____ 2.____ 3.____ 4.____ 5.____		
	g. Replacement: Place numbered or marked end of rings toward the bottom of the piston. Stagger the ring gap around the piston. Cover piston sides with oil. Using a piston ring compressor, install the piston in the cylinder and place cylinder on the mandrel or block.		
25	12. The propeller shaft thrust bearing retaining nut is checked for tightness at the first 25-hour inspection period after the engine has been installed in the airplane, and subsequent tightening is accomplished at the discretion of the Engineering Officer in charge. Such tightening on R-1830 engines is done by means of a proper wrench (40J3909) and adapter (40J3909-16). The nut is torqued to 600 foot pounds (T.O. 02-10CB-2, 02-1-34).		

LOCATION OF VALVE LIFTER ROLLER ON CAM



MAXIMUM UNCENTRALIZED CAM FLOAT CLEARANCE

(CENTRALIZED CAM FLOAT CLEARANCE IS .005 TO .007)

NO. 1 CYLINDER TOP DEAD CENTER COMPRESSION STROKE

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

ADJUSTMENT OF VALVE CLEARANCES by the POSITIVE method as given in T.O. 02-10CB-2, pp 46-7; T.O. 02-10-CB-3 pp. 92-3; T.O. 01-5EC-2, pp 209-10

Valve clearances should be checked after the first 25 hours of engine operation and at 300-hour periods thereafter. The clearances are adjusted in a sequence which conforms to the firing order of the cylinders. The following method places the cam in the same relative position on its bearing for the setting of each pair of valves and permits a positive setting with all the push rods in position.

1. Back off the valve clearance adjusting screws several turn to insure that the clearances are loose. Refer to the table listed below and place the piston of the first designated cylinder (No. 1) on top center of its compression stroke. The crankshaft should be turned in the normal direction of rotation for all operations.

2. Momentarily relieve the valve spring load on the two specified tappets (No. 9 intake and 7 exhaust), using two rocker arm depressors. The two tappets should be relieved, then slowly released simultaneously. This will allow the cam to slide over so that it is in contact with the bearing adjacent to the cylinder whose valve clearances are being set. Adjust the valve clearances of the specified valves (No. 1 inlet and No. 1 exhaust), setting each to .020 inch with the valve clearance gage.

CAUTION: Particular care must be exercised to make sure that the proper valves are depressed else a push rod may drop out of place and cause damage before it is discovered.

3. Adjust the clearance of all other valves in the same manner following the order shown in the table below. After setting all the valve clearances, turn the crankshaft two revolutions in the normal direction of rotation; then check each valve clearance with the proper piston at top center on the compression stroke again following the order shown in the table below. If, on this check, clearances are found which vary more than .005 inch from the specified clearance of .020 inch (in other words, if less than .015" or more than .025"), these clearances should be reset to the correct specified clearance of .020".

Adjust Valves .020 clearance		Set Piston TDC Compression	*Depress Valves	
Intake	Exhaust		Intake	Exhaust
1	1	1	9	7
10	10	10	4	2
5	5	5	13	11
14	14	14	8	6
9	9	9	3	1
4	4	4	12	10
13	13	13	7	5
8	8	8	2	14
3	3	3	11	9
12	12	12	6	4
7	7	7	1	13
2	2	2	10	8
11	11	11	5	3
6	6	6	14	12

* Depress these two valves simultaneously, then release slowly, before proceeding with adjustment of the valve clearances at the cylinder which has the piston on TDC of compression stroke.

4. If excessive valve clearances are found (.025 inch or more), the following procedure will be followed:

a. Remove and clean the necessary push rods and push rods covers.
b. Inspect push rods for straightness, wear on ball ends, and security of ball ends.
c. Inspect condition of packing in push rod cover nuts. Replace if necessary.
d. Re-assemble all parts and ascertain that both ends of the push rod covers fit properly in packings.
e. Recheck valve clearances and make proper adjustment thereof in accordance with the above instructions.

Explanation for Adjusting Valve Clearance by the Positive Method

On the R-1830-43 and -65, the twin rows of cam lobes are an integral part of the cam rim. The cam rim is driven by a gear which revolves the cam rim upon a cam bearing. If the clearance between the cam rim and the cam bearingwere centralized (as it is when the engine is running), this centralized clearance would average from .005" to .007". This centralized clearance is commonly called cam float.

When the crankshaft is turned slowly during the valve clearance adjustment procedure, there is a very strong likelihood that the cam float clearance does NOT stay centralized. In fact this cam float clearance may vary from almost .000" to as high as .014".

Thus the older method of valve clearance adjustment created a likely possibility of considerable error between the valve clearance set at .010" and the greatly variable cam float clearance of .000" to .014".

To take the extreme cases that could occur when using the older method - If one were setting the valve clearance at .010" on #1 cylinder and if the cam float clearance at the moment happened to be .000" at the point where the cam followers for the valves of this cylinder touch the cam rim, then later the running engine with its centralized average float clearance of .005" to .007" would reduce the actual valve clearance so that it would be .003" to .005" (cold). To take the opposite extreme, if one were to go on to #10 cylinder and set the valve clearance at .010" and if the cam float clearance at that moment happened to be maximum of .014" at the point where the cam followers for the valves of #10 cylinder contact the cam rim, then later the running engine with its centralized average float clearance of .005" to .007" would increase the actual valve clearance so that it would be .017" to .015" (cold).

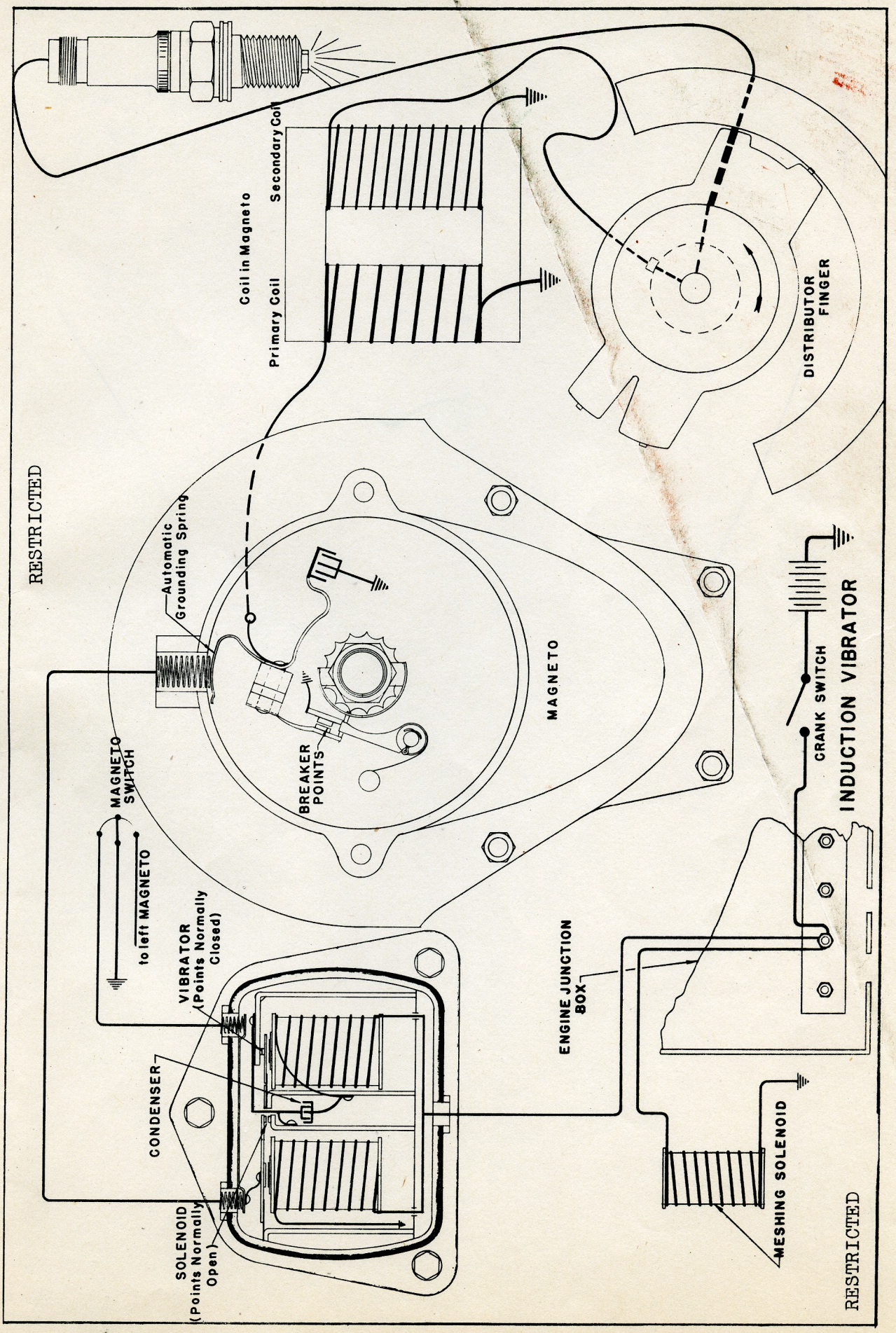
This possibility of error in valve clearance adjustment due to cam float is eliminated by using the Positive Method.

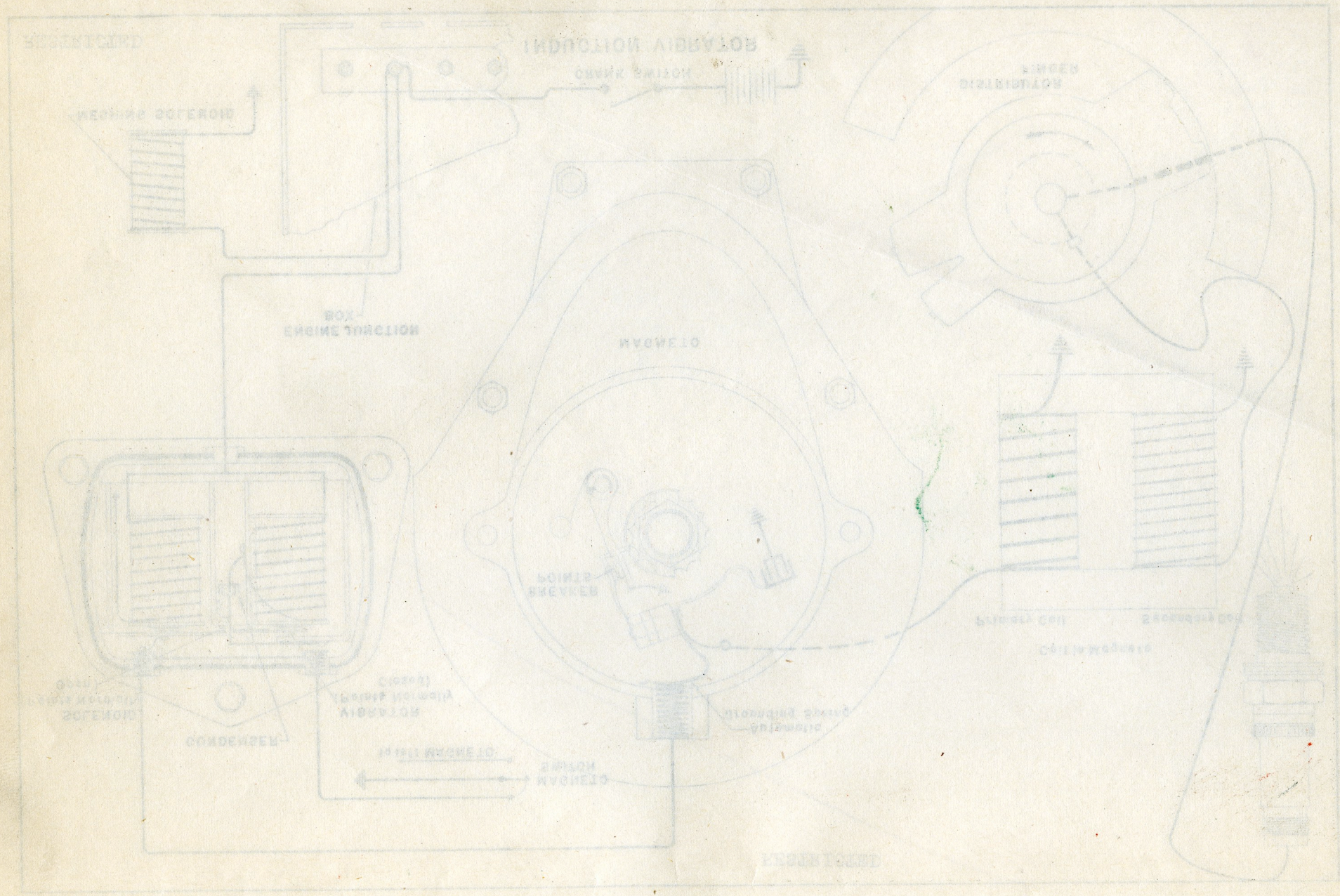
By depressing the outer valves of the opposite two cylinders in the same row, the cam rim is forced away from the valves on which the adjustment is going to be made: in other words, at that point the cam rim is forced against the cam bearing so that there is no cam float clearance at all at this point. The clearance on the valves is then set at .020" so that when the cam float clearance becomes centralized while the engine is running, the actual valve clearance will be .013" to .015" (cold).

To take a specific example: Suppose one were going to adjust the valve clearance on #1 cylinder. When #1 cylinder has been set on top center of the compression stroke, the cam followers for #1 Cylinder will be between two of the cam lobes: at the same time the cam followers for #3 and #7 exhaust and for #9 and #13 intake will be on the four cam lobes. Thus when #7 exhaust and #9 intake valves are simultaneously depressed, the pressure, (which the springs of these valves exerted on the lobes and thus also on the cam rim) is relieved: at this instant the pressure exerted by the springs of #3 exhaust and #13 intake valves on the other two (the upper) camlobes forces the cam rim on to the cam bearing. As the result, the cam rim rests directly on the cam bearing at the point where the cam followers for the valves of #1 cylinders are, and the cam float clearance has shifted to the opposite side, away from the valves to be adjusted. The cam rim will remain in this same position IF #7 exhaust and #9 intake valves are slowly released at the same time (that is, simultaneously), because the springs of #3 exhaust and #13 intake valves are continuing to exert pressure on the upper two cam lobes (however, if the two depressed valves are allowed to snap back quickly or unequally, there will most likely be some change in the cam float clearance - hence release must be SLOW and SIMULTANEOUS).

Similar action occurs when this positive method is used to adjust the valve clearance on the remaining cylinders in the engine firing order.

- Adapted from Buick's P & W Instructional Manual


RESTRICTED
Secondary Coil
Coil in Magneto
Primary Coil
DISTRIBUTOR FINGER
Automatic Grounding Spring
MAGNETO
BREAKER POINTS
MAGNETO SWITCH
to left MAGNETO
VIBRATOR (Points Normally Closed)
CONDENSER
SOLENOID (Points Normally Open)
ENGINE JUNCTION BOX
CRANK SWITCH
INDUCTION VIBRATOR
MESHING SOLENOID
RESTRICTED



Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

IGNITION SYSTEM

Parts followed by * to be located after removal of accessory or cover.

A. Location and Function

1. Magneto.
   a. Mounting flange.
   b. Gear housing.
   c. Drive coupling.*
   d. Breaker cover.
   e. Dust cover.
   f. Radio shield.
   g. Radio shield elbow.
   h. Ground switch connection (P-lead)
   i. Red dot on compensating cam.*
   j. Primary condenser.*
   k. Breaker points.*
   l. Coil assembly.*
   m. Distributor block.*
   n. Timing collar.*
   o. Distributor rotor.*
   p. Cam follower and spring.*
   q. Safety, Automatic Grounding Spring.
   r. Primary cable.
   s. Secondary, high tension terminal.*
   t. Booster coil connection.
   u. Breaker point adjusting screws.*
   v. Cable piercing screws in dist. block.*

2. Ignition Control Cable.
   a. Lead, left mag. to ignition cross.
   b. Lead, induction vibrator to ignition cross
   c. Lead, from ignition cross to ground.
   d. Cable, from ignition cross to wing firewall.
   e. Safety grounding cannon plug at wing firewall.

3. Induction Vibrator
   a. Mount, housing, and cover.
   b. Grounding plate.
   c. Positive outlet.
   d. Ignition switch outlet.
   e. Magneto outlet.
   f. Slotted nut and lock spring.
   g. Positive cable, post, clip, and screw.*
   h. Relay coil.*
   i. Vibrator coil.*
   j. Relay points.*
   k. Vibrator points.*
   l. Condenser.*
   m. Terminal nut (Spring contact).*
   n. Terminal strip.

4. Ignition Harness.
   a. Flexible conduit, mag. to pipe conduit.
   b. Pipe conduit.
   c. Flexible conduit, pipe to manifold.
   d. Ignition manifold.
   e. Braided conduit, manifold to plugs.
   f. Elbows.
   g. Conduit clamps.
   h. Braided conduit clamps.

5. Spark Plugs.
   a. Shielding barrel assembly.
   b. Shell assembly.
   c. Core assembly.*
   d. Core contact point.*
   e. Center electrode.*
   f. Ceramic core insulator.
   g. Ground electrode.*
   h. Bushing, (cylinder head).

Cylinder # →
wire # on block

Cylinder #
2 12 3 9 4 6 5 3
6 14 7 11 8 8 9 5 10 2
11 13 12 10 13 7 14 4 1 1
Firing order

ENGINE SYSTEMS

Job Sheet IV-10a

Airplane & Engine Mech Course (Special B-24)
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IGNITION SYSTEM

Col. No. Form 41B Interval	Inspection Required	Symbol	Remarks:
PF	1. Verify that ignition switches are off.		
D	2. Check magneto for:		
	a. Cracked housing and mounting flange.		
	b. Security of mounting.		
	c. Proper safetying.		
	d. Conduit for tightness and condition.		
50	3. Remove breaker cover and clean breaker housing.		
50	4. Check cam lubrication. Wipe off excess oil. Lack of lubrication is indicated when cam follower has a grayish-white color instead of reddish-brown, moist appearing surface, or if reddish color appears on cam. If this condition is found, magneto must be replaced.		
50	5. Inspect breaker points. A small amount of pitting and burning is permissible, but dressing or replacement is necessary in event of excessive pitting or burning. Never use a file, sandpaper or emery cloth to dress these points. (T.O. 01-5EC-2, p. 212).		
50	6. Check magneto timing and synchronizing. T.O. 02-10CB-2 and 03-5DC-1. (Refer to end of these inspection sheets for instructions).		
	7. Induction Vibrator. T.O. 03-5-2.		
PF	a. Check for operation by engaging the meshing switch. A buzzing sound should be heard.		
	b. Check for security of mounting and condition of leads.		
100	c. Check for security of lock springs securing slotted outlet nuts on ignition switch and magneto outlets.		
	d. Remove top cover and inspect condition of gasket. Gasket is shellacked to cover.		
	e. Check terminal nut assemblies for contact with terminal strip within the unit. If loose, tighten slotted nuts.		
	f. Check tightness of screws securing the positive cable to the unit. Tighten if necessary.		
	g. Check contact points for general condition and cleanliness.		
	8. Ignition Harness.		
	a. Inspect harness for security of mounting to rear section and to power section.		
	b. Inspect for tightness of ring nuts between pipe and flexible conduit.		
	c. Inspect for evidence of kinks and cracks in pipe conduit and manifold.		
	d. Inspect braided leads to plugs and elbows for tightness at connections and evidence of failure.		
	e. Replace ignition wire. Refer to end of these inspection sheets for instructions.		

Job Sheet IV-10b.

ENGINE SYSTEMS

Airplane & Engine Mech. Course (Special E-24)
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(b to d) IGNITION SYSTEM

Col. No.
Form

Interval	Inspections Required	Symbol	Remarks:
D	9. Spark Plugs.		
	a. Check spark plugs and connections for general condition and evidences of failure.		
	b. Remove plugs from No. 1 and 10 cylinders.		
	1. Inspect plugs and bushing threads for nicks burrs, and cross threads.		
	2. Inspect gap between electrodes. Clearance should be .011" to .014".		
	3. Inspect plugs for cracks, carbon, oil or fouling.		
	4. Install plugs, using thread lubrication and torque 300 to 360 inch lbs.		
	5. Install elbows. Caution: Excessive tightening will change the gap setting.*		
100	Note: On the 100 hour inspection, all spark plugs will be removed and replaced with new or reconditioned plugs.		

* This caution is especially applicable to mica spark plugs. So much trouble is being encountered in the removal and replacement of spark plug elbows that further cautions are added here to help remedy the situation:

1. It is recommended that the nut on the high tension lead be loosened a few turns BEFORE the nut on the spark plug elbow is loosened - this will greatly lessen the danger of cross-threading the elbow nut when re-installing the elbow.

2. When loosening or tightening the spark plug elbow nut, use one hand to hold the elbow - This precaution is to insure the prevention of twisting the elbow itself or damage to the lead and its shielding which might result if the elbow twisted.

3. The high tension lead connector (or cigarette) should be removed from or inserted in the spark plug terminal well with great care. When removing, pull carefully, DO NOT JERK, the connector <u>straight</u> out from the plug, and likewise when inserting; avoid tilting the connector and avoid applying a side load on the plug barrel - This is to prevent damaging either the insulator or the lead connector or both (T.O. 03-5E-1. Sec. II, para. 4,5).

4. When removing the lead connector (or cigarette) from the lead, remember that the wire projecting through the connector must first be straightened before it can be removed.

5. After the connector has been inserted in the spark plug, start the elbow nut by hand and screw on finger-tight. Then with a wrench torque ONLY sufficiently to insure a snug fit.

6. Exercise care to prevent scratching and/or marring the elbows.

IGNITION SYSTEM (Cont'd)

7. Be sure that you use the proper angled elbow:
   a. 110° elbows on both front and rear spark plugs in the rear row of cylinders:
   b. 110° elbows on the rear spark plugs in the front row of cylinders (except on #8 cylinder).
   c. 70° elbows on the front spark plugs in the front row of cylinders and on the rear plug of #8 cylinder.
8. REMEMBER that:
   a. Use of the right type and size of wrench is of greatest importance to prevent damage to internal plug parts.
   b. Excessive tightening of the spark plug itself may make it hard to remove for the next servicing; such excessive torque may also compress the gasket out of shape thus losing the gas-tight seal besides imposing an overload which stretches the threads and results in dangerous loosening of plug parts; furthermore, the excessive torque may distort and stretch the plug to such a degree that breakage of the shell would result when the plug is subsequently removed or installed, or the plug shell damage may be such that it ultimately results in a "blown out" center electrode or core insulator.
   c. Experience in the field indicates that the damage which makes ceramic plugs inoperative, has usually occured in the handling, installation, removal, or servicing operations. Only rarely does a spark plug become inoperative because of failure of some plug part. Normally the only wearing part of the spark plug is the electrodes; with proper servicing ceramic plugs can operate efficiently for 300 hours. (Buick's P & W Instruction Manual, p. 291)

REMOVAL OF SEIZED SPARK PLUGS FROM CYLINDERS

Ethyl Chloride may be used to remove seized spark plugs from engine cylinders without destroying the threads in the adapter bushing. The ethyl chloride is poured either into the hollow insulating sleeve or into a short piece of hose placed over the spark plug so that it forms a seal at the gasket flange. Rapid evaporation of the liquid cools the plugs sufficiently to permit easy extraction. (T.O. 01-5EC-2, p. 204).

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REPLACING IGNITION WIRE (T.O. 02-10CB-2)

If there are indications that an ignition wire is defective, the wire will be located and replaced as follows. The instructor may wish to add or omit certain steps.

1. Determine which wire is to be replaced, and obtain a new wire of the correct length. See T.O. 02-10CB-3, p. 100 for proper lengths.
2. Remove spark plug connection from the end of the wire.
3. Remove braided conduit and spark plug elbow from wire by unscrewing the union nuts at each end of the conduit.
4. Disconnect the one or all the wires from the distributor block. CAUTION: Be careful that identification bands are not lost from the wires.
   a. Remove radio shield elbow and conduit if all the wires are removed from the distributor block.
5. Unscrew the union nut which fastens the pipe assembly to the manifold and slip the assembly back toward the distributor block after doing step 7.
6. Remove the four cap screws that fasten the manifold to the front of the power section.
7. Remove as many elbows from spark plugs as is necessary to allow manifold to be pulled forward enough to locate wire where union nut fastened to pipe assembly. Pull the wire out enough here to form a small loop.
8. Determine in which direction the old wire will move more easily and splice and/or solder an end of the new wire to that end of the old wire.
9. Dust the new wire with talc or soapstone to prevent it from binding or seizing when being installed in the manifold.
10. Pull the old wire out and at the same time feed the new wire into the manifold. Be sure to maintain a loop at the union nut so that the wire will be pulled straight and not around corners. CAUTION: It is necessary to perform this operation carefully so as not to injure the protective coating of the new wire.
11. When the new wire has been pulled through the manifold far enough, cut off to proper length at each end.
12. Replace conduit and radio shield elbow, if removed. Place clip on distributor end of wire and then insert the wire into the block.
13. Fasten the pipe assembly to the manifold, manifold to front of power section, replace braided conduit and elbow to new wire, and then connect all the loosened elbows to their respective plugs. (The spark plug elbows should be tightened only enough to insure a snug fit. These elbows tend to turn when the attaching nuts are tightened. This may cause damage to the elbows, particularly on the front mounted type harness, as well as possible failure of ignition lead insulation. Therefore, particular care must be taken to hold elbows to prevent them turning while tightening the attaching nuts. Furthermore, on at least some types of spark plugs, excessive tightening of the elbow may change the gap setting of the spark plug.)

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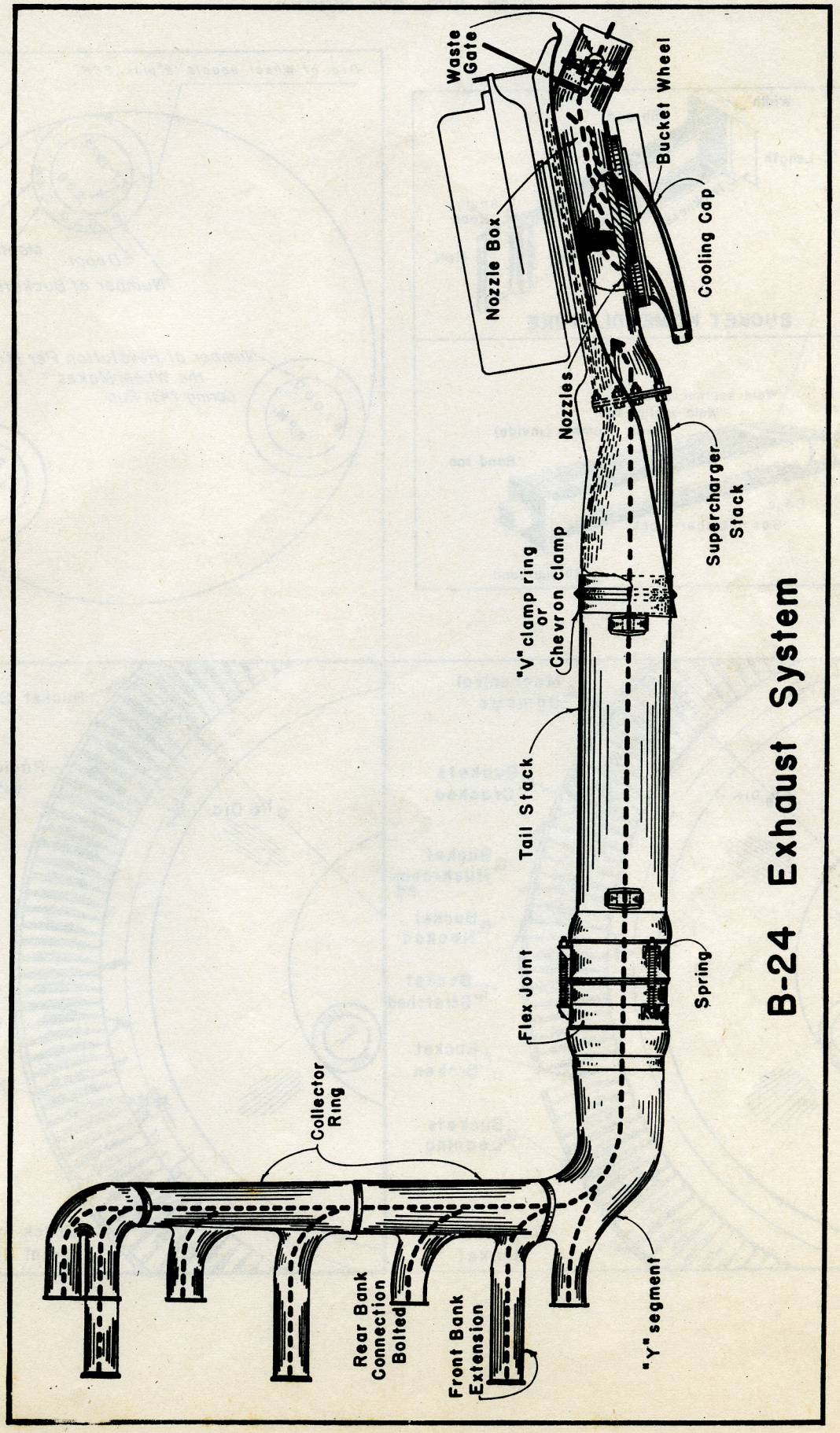
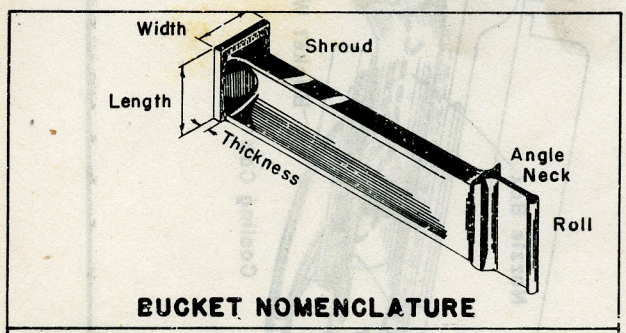
IGNITION SYSTEM

Questions

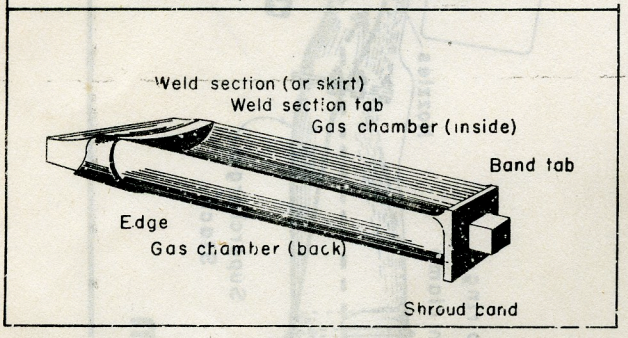
1. What is the purpose of the red dot on the compensated cam?
2. What is meant by synchronized timing?
3. Suppose you replaced a magneto, but it is not in step, or the studs are not in approximate center in the slots--what would you do to correct the situation?
4. In synchronizing magnetos, why is it so important to have both lights going out at the same time, rather than coming on at the same time when using the "home-made" timing light?
5. Right magneto fires which plugs?
6. What type plugs are used? (T.O. 03-5E-3)
7. What is the spark advance on this engine?
8. Are these plugs cleaned with sand blast? (T.O. 03-5E-1)
9. What is meant by compensated magnetos?
10. Where are the magnetos grounded, when switches are "OFF"?
11. Are the magnetos "on" if the "P" lead is removed from magneto?
12. Are the magnetos "on" if the cannon plug is removed or opened at the firewall? (T.O. 01-5EC-2, p. 37, bottom col.)
13. Where is the booster "in" connection on the magneto?
14. Where is the induction vibrator "in" connection on the magneto?
15. What is the speed of the distributor?Of the induction rotor?
16. When should the mechanic readjust the breaker plate?
17. Is it possible to change the timing of the distributor $\frac{1}{4}$ tooth?
18. When mounting a magneto, how many timing settings are available?
19. What spark plug gap tolerance is allowed?
20. What torque is used to tighten plugs?
21. What torque is used to tighten spark plug elbows?
22. What inspection is made on spark plugs?
23. What is done to spark plugs on 100 Hr. Inspection?
24. What advantage has the induction vibrator over the booster coil?
25. If relay coil or points fail to operate, what might the trouble be?
26. If vibrator coil or points fail to operate, what might the trouble be?
27. Which magneto is the induction vibrator attached?
28. Which plugs does the induction vibrator fire?
29. How is the induction vibrator turned off?
30. Why doesn't the vibrator ground out the magneto when the meshing switch is released?
31. How many ignition wires are housed in ignition harness?
32. Are all the wires the same length?
33. What material is used for a lubricant when replacing ignition wires?
34. Will a plug fire if there is an opening in the wire? Would altitude make any difference?
35. How would you check for an open circuit in an ignition wire?
36. Should you splice an ignition wire?
37. Is the ignition wire soldered to the cigarette? (T.O. 02-10CB-3, p. 102).
38. Between which cylinders does the ignition harness pass?
39. Is it necessary to remove any cylinders in order to replace the ignition harness?
40. How is the wire fastened into the distributor block?
41. Can the lead assembly be replaced at the harness?
42. How is harness attached to engine?
43. Is the harness supercharged?

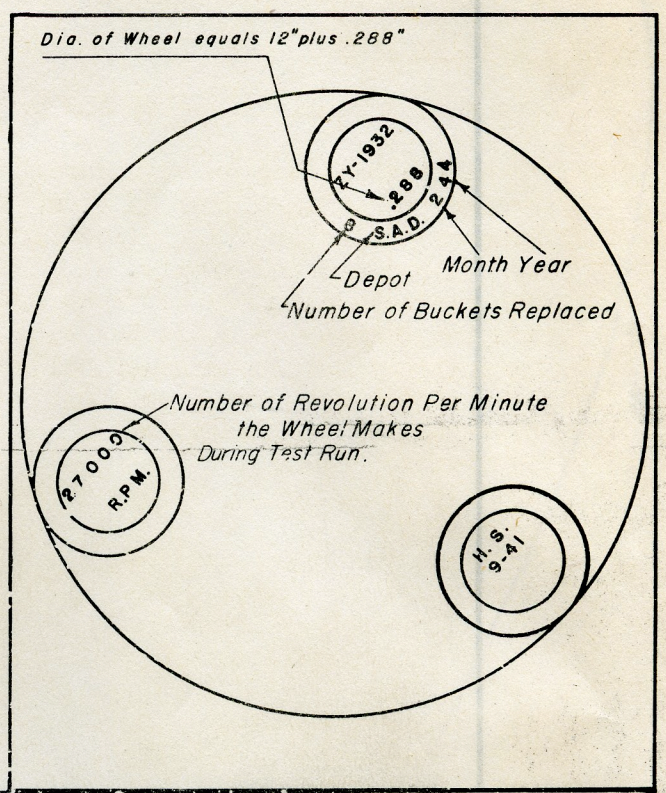


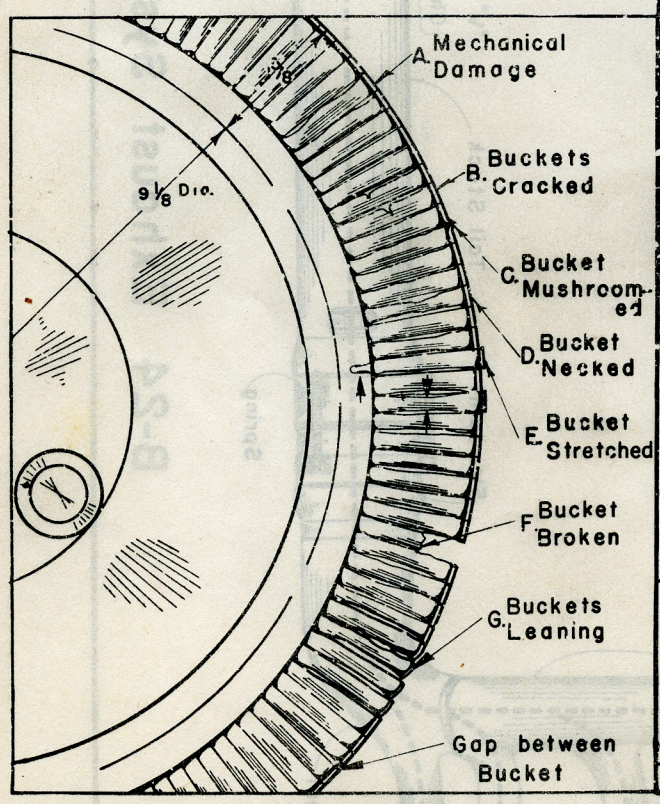
B-24 Exhaust System

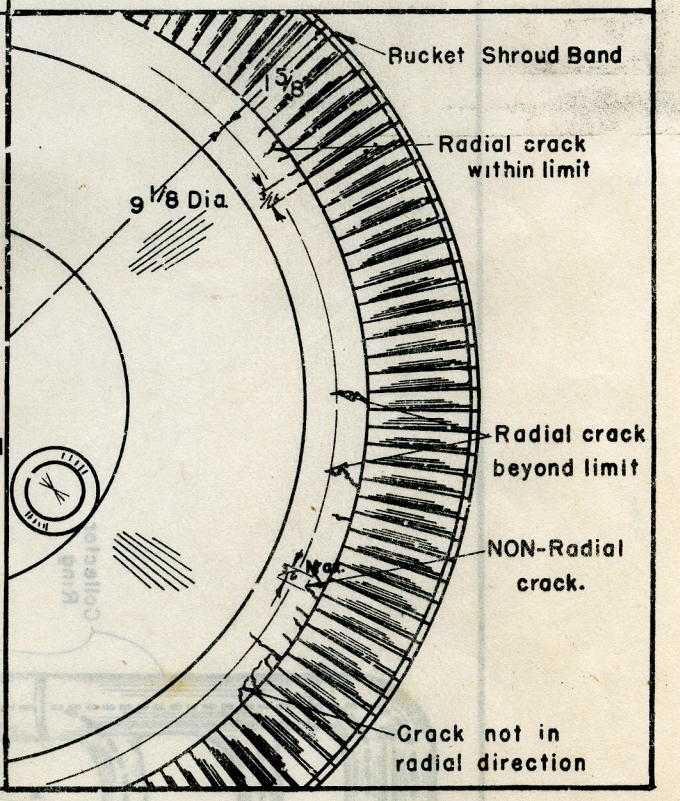


BUCKET NOMENCLATURE









Airplane & Engine Mech Course (Special B-24)
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EXHAUST AND TURBOSUPERCHARGER SYSTEMS

I. Location and Function

Locate each unit listed below and be able to state its function.

1. Exhaust extensions on cylinders.
2. V-clamp (chevron clamp) on front bank extensions.
3. Exhaust collector ring, 7 sections.
   a. Half clamp and nipple.
4. Short stacks attached to front cylinders.
5. Adapter flanges on collector ring, for rear row of cylinders.
6. Expansion joints on exhaust collector ring.
7. Exhaust collector ring shroud.
8. Diaphragm or engine firewall.
9. Tail stack shroud.
10. Ball joint assembly, spring loaded (Flex joint in tail stack assembly.)
11. Tail stack forward section.
12. Tail stack V-clamp.
13. Tail stack aft section.
14. Turbo compressor casing.
15. Baffle ring.
16. Supercharger shroud.
17. Turbo tachometer connection.
18. Turbo oil pump.
19. Bearing and pump casing.
20. Nozzle boxes.
21. Bucket wheel and buckets.
22. Cooling cap.
23. Waste gate pipe and waste gate.
24. Supercharger regulator and mounting bracket.
25. Supercharger regulator exhaust balance line.
26. Turbo-supercharger mounting brackets.
27. Pressuretrol.
28. Turbo governor
29. Waste gate motor.
30. Nacelle junction box

Airplane & Engine Mech Course (Special B-24)
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EXHAUST AND TURBOSUPERCHARGER

Col. No. Form 41B Interval	Inspections Required	Symbol	Remarks
50	1. Inspect V-clamp bolts on front bank extensions for proper installation, tightness, and safetying.		
S	2. Remove one of the V-clamps, check its condition and re-install applying a torque of 35 to 50 in.-lbs., safety with cotter key. The correct part no. on the clamp should be 55470. See T.O. 02-10-38.		
50	3. Inspect rear row adapter flange bolts for proper safetying and general condition.		
S	4. Remove the flange bolts on one cylinder, inspect, replace if defective, retighten to 50 in. lbs. (If cotter pin holes do not line up, back off the nut as required for proper alignment.) Resafety nuts with .032 inch wire. T.O. 01-5-63 & 01-5-15.		
50	5. Inspect for cracks and evidence of leakage at: a. Short stacks. b. Collector ring. c. Exhaust extensions.		
25	6. Inspect the spring loaded ball joint assembly for the proper installation and general condition. Note the arrow on the male portion. Turn the joint by hand to make sure it is free and adjusted evenly.		
D	7. Inspect the forward tail stack for proper anchorage and general condition. (Anchored to tail stack shroud brackets by four bolts).		
50	8. Inspect V-clamp on tail stack for safetying and general condition.		
D	9. Inspect aft tail stack for proper anchorage and general condition. Note 12 bolts which fasten stack to supercharger.		
D	10. Check the turbosupercharger for security of mounting, (2 side brackets front fork and 1 rear bracket) and for evidence of failure.		
PF	11. Inspect the waste gate for: a. Evidence of warping. b. Corrosion. c. Freedom of movement--laterally and from the open to the closed position. Note: Disconnect waste gate linkage before attempting to open or close waste gate on electronic regulator installation. d. Proper clearance between waste gate and waste pipe when gate is closed should be from .020 to .045 inches. T.O. 01-5EC-2, page 231.		
D	12. Inspect turbo for oil leaks at bearings and oil lines. Repair leaking condition. Note: Oil seepage from the turbo oil seal onto the bucket wheel and cooling cap is permissible when the turbo is idle. T.O. 03-10DA-1		

Job Sheet IV-12b

ENGINE SYSTEMS

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

EXHAUST AND TURBOSUPERCHARGER SYSTEMS

Col.No. Form 41B Interval		Inspections Required	Symbol	Remarks:
PF	13.	Inspect bucket wheel: a. Rotate wheel for freedom of operation. Listen for unusual noises of internal rubbing or indication of bearing failure.		
		b. Check the turbine wheel for cracked or defective buckets. (see diagram).		
		c. Check for bucket looseness by applying a slight pressure to the bucket tip at a right angle to the face of the wheel. T.O. 01-5EC-2, page 52.		
D	14.	Inspect the bucket wheel disk directly above the cooling cap rim for run-out by revolving the bucket wheel slowly by hand. If run-out appears, it may be measured by placing a feeler gage between one point on the cooling cap and a point on the bucket wheel rim just inside the point where the buckets are attached to the wheel. However, for best results use dial indicator. Maximum run-out is .005 inches. T.O. 01-5EC-2 and 03-10DA-1.		
PF	15.	Check nozzle box clearance in 4 equally spaced places by inserting a feeler gage between bucket wheel and nozzle box. Allowable clearance is from .070 to .160 inches. T.O. 03-10DA-1.		
PF	16.	Measure the clearance between the cooling cap and turbine wheel. If the maximum clearance is greater than .190 inches or if the minimum clearance is less than .090 inches, rearrange the shims supporting the cooling cap until the clearance is within these limits around the entire rim of the cooling cap. T.O. 03-10DA-1.		
100	17.	Inspect the total side play (radial play) of the turbo rotor for bearing wear. A dial indicator is used for the best results, but a rough approximation may be obtained with a screw driver and feeler gage in the following manner. Hold the screwdriver in a vertical position so that the end of the blade is against the nozzle boxes and the face of the blade tip rests against the end of one of the buckets. Push the bucket wheel horizontally in a direction away from the screwdriver and measure the clearance between the screw-driver and bucket. The maximum allowable play is .003 inches, T.O. 03-10DA-1. .012 inches, T.O. 01-5EC-2.		
100	18	Inspect the total end play (Axial play) of the turbo rotor for bearing wear. A dial indicator is used for best results but a rough approximation may be obtained with the use of only a feeler gage in the following manner. Make a mark on the rim of the bucket wheel and a mark on the nozzle box so that the two marks are in line.		

EXHAUST AND TURBO-SUPERCHARGER SYSTEMS.

Col.No. Form 41B. Interval		Inspections Required	Symbol	Remarks:
		Measure the nozzle box clearance at this point. Then, move the bucket wheel up and measure the clearance again at the same point. The difference between the two readings gives the end play. The maximum allowable end play is .009 inches, T.O. 03-1ODA-1.		
D	19.	Inspect the turbine wheel buckets for: See diagrams for details. a. Mechanical damage as nicks, dents or gouges. b. Cracks. c. Mushrooming or upsetting. d. Necking. e. Stretching. f. Breaks. g. Back-lean. h. Gaps between adjacent buckets.		
D	20.	Inspect for cracks in welded wheels. See diagram for details.		
D	21.	Inspect the nozzle box for cracks, especially in the weld. Inspect the inside of the nozzle diaphragm and the bucket wheel and look through the space between the buckets. Cracks over 1 inch in length or of such condition to permit leakage are cause for removal of the turbo.		
D	22.	Inspect the nozzle blades for buckling by looking between the buckets of the turbine wheel and the nozzle diaphragm.		
PF	23.	Inspect the nozzle box and cooling cap for loose bolts and broken safety wire. Replace any stretched bolts and make repairs that are necessary. Inspect condition of cooling cap.		
D	24.	Check the balance line, making sure it cannot chafe where it passes through the shroud and that it has no low spots or dips to accumulate moisture where it might freeze. See T.O. 01-5-30 for rerouting exhaust balance line.		
50	25.	Inspect the turbo regulator control bracket for cracks in the webs. See T.O. 01-5E-53 for repair procedures and diagrams.		
50	26.	Check the turbo regulator for: a. Proper mounting and security of attachment. b. Proper attachment of oil pressure and drain lines. c. Faulty gaskets and excessive oil leakage at servo piston rod. Note: A leakage of one drop per minute at 71°C and pressure of 50 p.s.i. is permitted.		
D	27.	Inspect the following for security of attachment and general condition: a. Engine firewall. b. Collector ring shroud. c. Tail stack shroud. d. Supercharger shroud.		

c. Function: To provide a means of interconnecting the various units of the control system and act as a central checking point for ciruit failures.

4. Inverters:

a. Installation: Two inverters are located in the nosewheel compartment.

b. Connections & Function: The power for the complete control system is taken from one of the two 400-cycle, 115 volt inverters. The main power connection is made at the inverter fuse in the co-pilot's fuse box. In some ships, an additional fuse is used in the main power output line of each inverter. These fuses are installed in the inverter fuse box, located beneath the floor of the radio room a short distance to the left of the inverter.

5. Pressuretrol:

a. Installation: Located on the engine mount on the left side of the carburetor intake duct, slightly forward and above the left magneto.

b. Connections: Rubber tube from Pressuretrol bellows to carburetor air scoop. Wired in series between Manifold Pressure Selector and Governor.

c. Function: Registers air pressure from carburetor air scoop, the action of which actuates wiper arm over control quadrant when bellows contract or expands.

6. Governor:

a. Installation: Located at right rear side of turbo, just above the shroud between the impeller housing and nozzle box.

b. Connections: Driven through a flexible drive taken off the tachometer connections of the turbo oil pump. Wired in series between Pressuretrol and Waste Gate Motor control quadrant.

c. Function: 1. Overspeed---prevents overspeeding of turbo by use of fly-weights which throw out at approximately 24,000 RPM turbo speed thereby engaging clutch which causes wiper arm to move over control quadrant sending signal for "open" waste gate action.

2. Accelerometer---Prevents overshooting of manifold pressure, yet allows very rapid acceleration of the turbo by use of inertia wheel which floats on shaft connected to drive shaft by torque spring. Sudden torque of shaft transmits energy to inertia wheel through spring causing wheel to slide along shaft and operate push pin. Push pin moves wiper arm over control quadrant sending signal for "open" waste gate action.

7. Waste Gate Motor:

a. Installation: Located at rear of turbo about 10 inches above the waste gate.

b. Connections: Connected by mechanical linkage from motor operated arm to waste gate shaft. Wired in series between governor and amplifier and between amplifier and ground.

c. Function: Opens or closes waste gate according to direction of motor rotation in response to control signals. It also operates a balancing potientiometer which produces a signal opposed to the original control signal.

When the rotation of the motor is enough to make the two signals exactly neutralize each other, the power from the amplifier is cut off and the waste gate motor stops.

8. Nacelle Junction Box:

a. Installation: Mounted on the supercharger mounting brackets just above the heat baffle (shroud) on all four engines. All four "J" boxes are located on the left side of their respective turbos.

b. Connections: Wire harnesses of Pressuretrol, Governor, and Waste Gate Motor join at this box and are connected to Main Junction Box through a single harness.

c. Function: Acts as a checking point for circuit and unit failures at the nacelle.

The Manifold Pressure Selector, Pressuretrol, Governor, Waste Gate Motor, and Amplifier are all wired in series thus composing a bridge control unit. A failure occuring in any one of the nacelle units will result in failure of operation of the entire control system for that engine only.

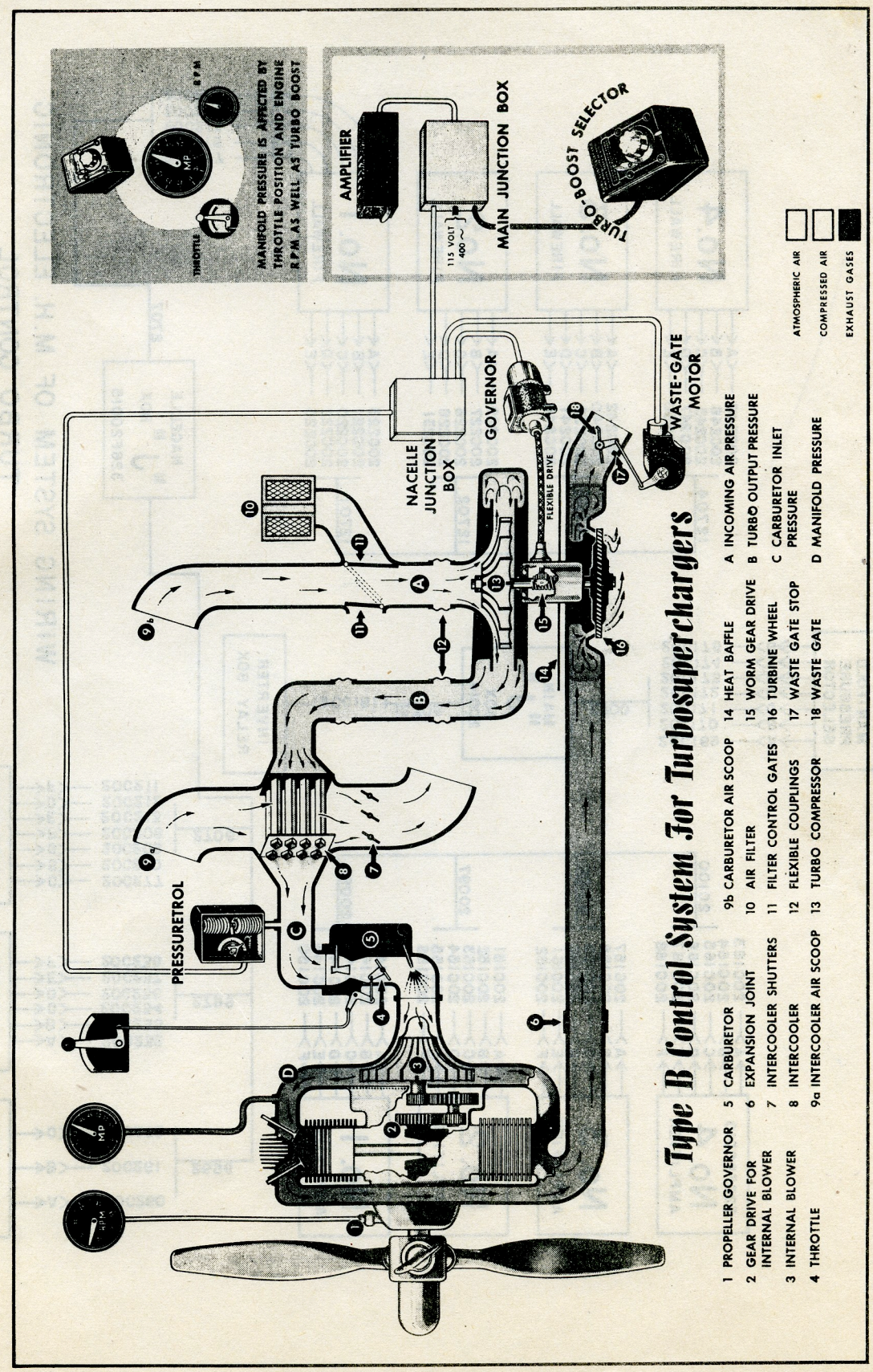
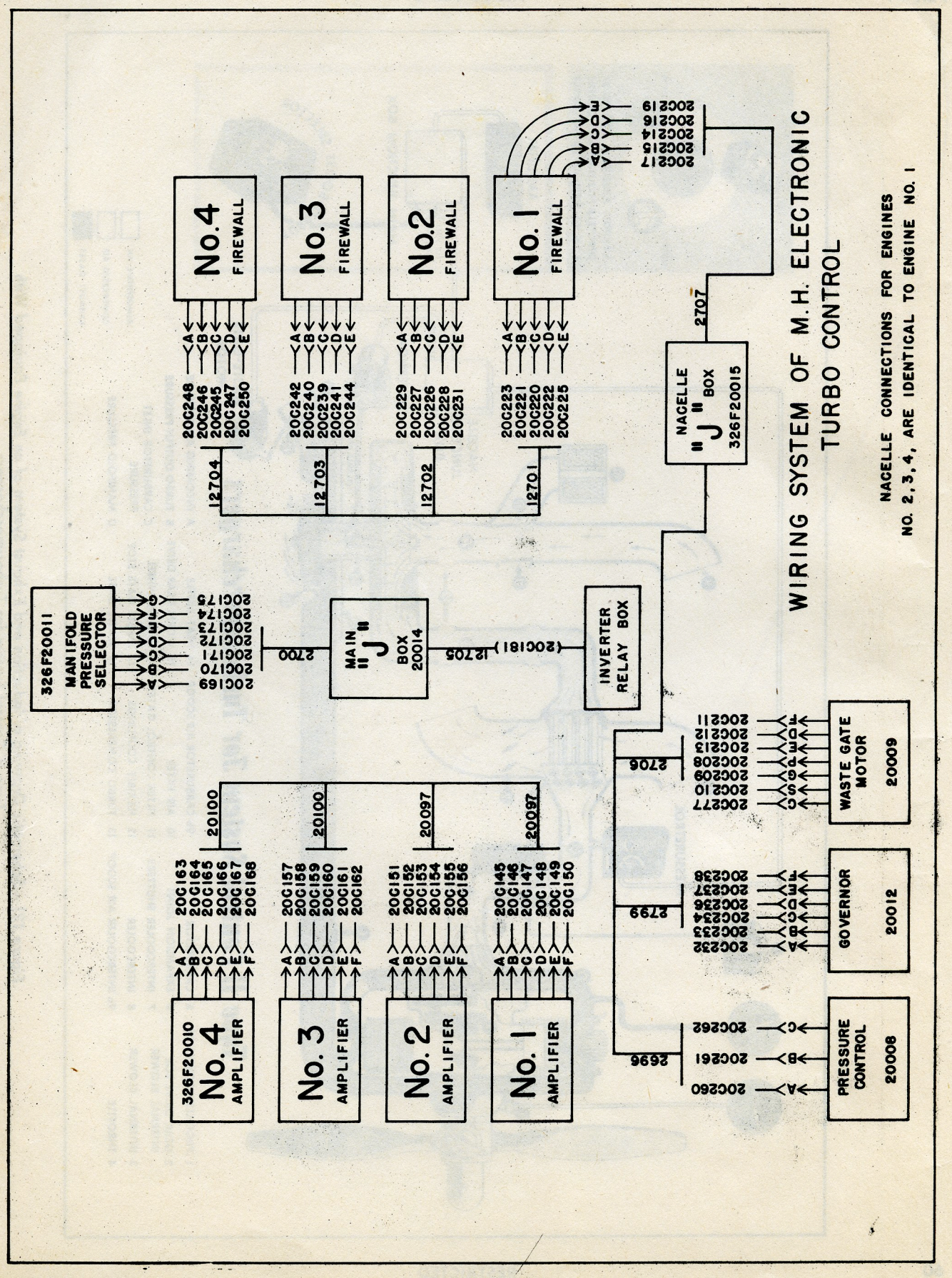


Figure 121—Schematic Drawing of Induction and Exhaust System of an Engine Equipped With Type B Control System for Turbosuperchargers


WIRING SYSTEM OF M.H. ELECTRONIC TURBO CONTROL
NACELLE CONNECTIONS FOR ENGINES NO. 2, 3, 4, ARE IDENTICAL TO ENGINE NO. 1
No. 4 FIREWALL
No. 3 FIREWALL
No. 2 FIREWALL
No. 1 FIREWALL
NACELLE "J" BOX 326F20015
MAIN "J" BOX 20014
INVERTER RELAY BOX
326F20011 MANIFOLD PRESSURE SELECTOR
326F20010 No. 4 AMPLIFIER
No. 3 AMPLIFIER
No. 2 AMPLIFIER
No. 1 AMPLIFIER
PRESSURE CONTROL 20008
GOVERNOR 20012
WASTE GATE MOTOR 20009
12704
12703
12702
12701
2707
2700
12705
2706
2799
2696
20100
20097

Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

ELECTRONIC TURBO SUPERCHARGER CONTROL SYSTEM (AN-03-10D-6)

I. General Location of Units in the System:

A. Located in fuselage of plane:
1. Manifold Pressure Selector.
2. Amplifiers for all four engines.
3. Main Junction Box.
4. Inverter.

B. Located in each engine nacelle:
1. Pressuretrol.
2. Governor.
3. Waste Gate Motor.
4. Nacelle Junction Box.

II. Detailed Location and General Function of Individual Control Units:

1. Manifold Pressure Selector:

a. Installation: Located on the control pedestal adjacent to the throttle quadrant, replacing former installation of turbo control levers.

b. Connections: The Pressuretrol, Governor, Waste Gate Motor, and Nacelle Junction Box of each engine are connected in series with a Calibrator on the Manifold Pressure Selector. The Calibrator of each engine is then shunted into the main control quadrant.

c. Function: Controls increase or decrease of manifold pressure by movement of main control knob over control quadrant.

2. Amplifiers:

a. Installation: In some installations, they are located beneath the floor of the radio room between stations 2.0 and 4.0 or they may be mounted on one platform at station 4.0.

b. Connections: Wired in series between signal system and waste gate motor field winding.

c. Function: Amplifier contains four tubes: one (7Y4) rectifier supplies a high d-c voltage to the two plates of the (7F7) tube; one (7F7) amplifier which increases the strength of the bridge signals and then transmits them to the grids of the (7C5) tubes; and two (7C5) discriminator or detector tubes, one of which detects signals calling for the waste gate to open whereas the other detects signals calling for the waste gate to close.

3. Main Junction Box.

a. Installation: On some models it is located beneath the floor of the radio room at station 3.2, approximately in the center of the airplane in front of the hatchway; on others, at station 4.0-several inches above radio room floor, on starboard side behind radio operator.

b. Connections: Wire harnesses of Manifold Pressure Selector, regulator units from the four engines, and all four Amplifiers join in this box with the inverter circuit.

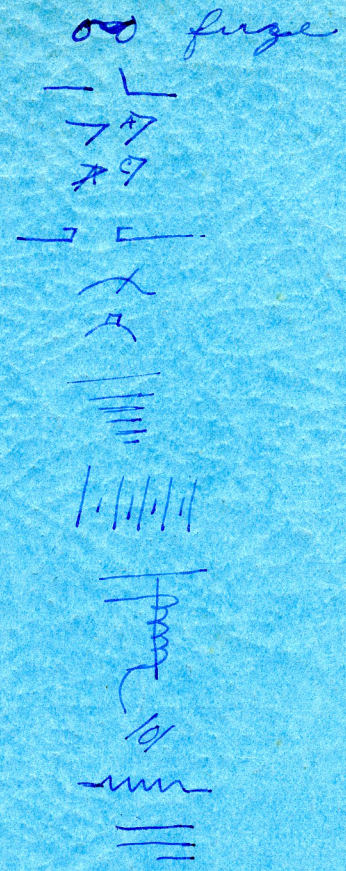
Airplane & Engine Mech Course (Special B-24)
FORD AIRPLANE SCHOOL

INSPECTION OF ELECTRONIC TURBO SUPERCHARGER CONTROL SYSTEM
(AN-03-10DC-6)

Col.No. Form 41B	Interval	Inspection Required	Symbol	Remarks:
		NOTE: The following inspections are only a partial list of those required on the Electronic Turbo control. The complete inspection guide will be used whenever the entire system is to be checked.		
10	*PF	1. Check waste gate for warpage, bending, or binding. (Do not try to open or close waste gate while linkage is connected to the waste gate motor.)		
*	PF	2. Turn dial clockwise to stop on selector. When stop is reached, arrow should point to "8". Press dial stop latch and turn dial to "0". The dial-stop latch should work freely. Turn dial counterclock wise to a point below "8" and check to see that dial stop re-engages. Return dial to "0" before starting the engine.		
*	D	3. Jiggle waste-gate linkage to make sure there is no binding in linkage bearings. Also inspect linkage rod for shiny spots or wear, which would indicate it had been scraping against the fairing or other airplane structures.		
*	25	4. On the governor, check AN connector nut on flexible-drive connection for tightness. Check governor for security and shifting of position.		
*	25	5. Check to see that there is at least ½" clearance between the linkage rod and any structural part of the airplane for all positions of the waste gate. This is necessary due to the heat expansion in the exhaust stacks and turbo.		
27*	25	6. Inspect hose which connects Pressuretrol to air scoop for leaks, cracks, and tightness of connections. A leak will cause manifold pressure "hunting" at certain powers or altitudes.		
	*25	7. Wiring harness is regularly inspected every 50 hours. In very humid climates it may be necessary to inspect the harness more frequently. Under these conditions the long cables inside the wing and inside the engine nacelles are checked every 25 hours for corrosion and accumulation of moisture inside the covering on the cable. If wing and nacelle disconnects are used, they should be inspected for good contact.		
27	*50	8. Check Pressuretrol Lord mounts, and if rubber is badly cracked, replace mounts. At sea level, wiper should be about one-fourth of the distance up from the bottom of the potentiometer winding. If wiper is above the center of the potentiometer winding, the pressuretrol may be out of calibration, or the reference bellows may be leaking. ~~Where altitude of air base is above~~		

Col. No.
Form
41B

Interval	Inspections Required	Symbol	Remarks:
	5,000 feet, normal position of wiper will be slightly above center of potentiometer winding. Calibration is Fourth Echelon work. Inspect all soldered connections. Inspect base of AN-connector pins for loose strands of wire. NEVER OIL ANY PART OF THIS UNIT.		
*50	9. Check Nacelle "J" Box terminals for loose connection and wires for breaks. Check mounting of condenser and transformer. Check condensers for oil leakage and replace if leaking. Inspect soldered connections on two 50,000 -ohm resistor and on condensers. Check condition of Dzus fasteners. In moist, humid climates, check transformers for deterioration of insulation and for corrosion around leads and terminals inside "J" boxes.		
*100	10. Disconnect flexible drive at Governor end, pull out the flexible shaft and inspect for wear. Lubricate if necessary (Grease Specification AN-G-3a). If drive is worn at some point replace complete drive. Replace flexible shaft. After sliding it into the housing, press it inward and turn until it slips into place engaging the drive connection on the turbo. Reconnect flexible drive to the governor.		



Power
RHS - RH Pannel
LHSeqt 4:1 - L H Pannel
4:1 forward LHS. - battery bus

2014-36 Kruse